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SOIL SURVEY REPORT

NIOKA AREA

ITURI - BELGIAN CONGO

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DESCRIPTION OF AREA

Location

The area investigated, which is nearly 100,000 hectares in extent, lies in northeastern Belgian Congo on the Congo-Nile divide. It is about 110 kilometers northeast of the town Irumu and roughly 75 kilometers north of Bunia. Stanleyville, the major city in the area, is about 800 kilometers to the southwest. Lake Albert is 80 kilometers to the east. The extremities of the area lie between the coordinates 30°34' and 30°51' East longitude and 2°10' and 2°25' North latitude. Figure 1.

Locally the area in general extends to the north and east from the village of Nioka to the Uganda boundary. It is bounded on the west and south by the Nioka-Gabu-Golu Road and the Nioka-Mahagi highway. A line running due east from Golu to the Uganda boundary marks the northern edge of the area while a line due south of this point on the Uganda border bounds the area on the east.

Topography and Relief

The area lying on the Congo-Nile divide occupies parts of the upper watersheds of several steams tributary to one or the other of these two river systems. The more important of the streams in the area are the Shari-Loluda and the Aoda draining to the southwest and the Omi to the north all tributary to the Congo River. The eastern part of the area is drained by the Niagaki-Veda system flowing into the Nile.

It is an area of considerable relief and rolling to very hilly or mountainous topography. The difference in elevations between the highest and the lowest points in the area is around 200 meters. The lowest elevations are around 1600 meters above sea level and occur along the lower reaches of the larger streams. The highest points in the area are slightly over 1800 meters above sea level.

Most of the mountainous topography occurs in the general portion of the area and covers much of the divides between the Shari-Loluda, the Omi and the Niagaki Rivers. It includes the more prominent, frequently highest rock-capped ridges and interfluves between these streams and some of their tributaries. The slopes are steep, often having a gradient of over 50 per cent. A few small isolated areas designated as mountainous were also found in the southeastern and in the extreme western parts of the area.

The remainder of the area is rolling to hilly. It consists generally of extensive smooth-sloped hills or interfluves with a convex lateral cross section. These interfluves range from a few hundred meters up to one or two kilometers in width and may be several kilometers in length, depending on the length of the bordering streams or drainage ways. The summits or crests are generally nearly level or gently sloping; but the lateral slopes become progressively steeper as the streams are approached, frequently attaining a gradient ranging from about 10 per cent to about 20 per cent. These long smooth slopes are often steepest next to the valley floor. The crests of many of the interfluves show but little downstream gradient and appear to be nearly level for considerable distances.

Streams with definite channels are rare in the area. With few exceptions the streams consist of wide (up to several hundred meters in some cases), flat-bottomed; papyrus-choked drainage-ways. The water moves slowly through the maze of papyrus and marsh grass roots and debris.

Climate

The climate of the area is humid cool tropical. At the Nioka Station it is classed as being Warm Temperate Rainy (Cf according to the Koppen system). The area is a transition zone, so a part of it has a tropical savanna climate Aw. (3).

The annual average rainfall of 1325 mm is not evenly distributed and shows two periods of maximums or rainy seasons (4). The first occurs in April and May while the second period of maximum rainfall extends from July to November. The period from December to March is relatively dry and is the period during which much of the vegetation dries up or sheds its foliage. This is the period when much of the savanna cover is burned.

The rainfall of the area is often of a torrential type coming as heavy showers of high intensity. A 24-hour maximum of 79.5 mm has been recorded. Such a rainfall produces considerable run-off and where vegetation is sparse or lacking, some local erosion. The hummocky micro-relief where the hummocks of soil have formed around grass bunches is likely the result of intense rain drop impact erosion associated with this type of rainfall.

In contrast to rainfall, the temperatures are considerably more uniform. No freezing temperatures are reported. The monthly means show but slight variation ranging from 17.9°C for July to 20.2°C for April. The annual mean is 19.2°C. Diurnal variations are moderate. The nights are cool with temperatures as low as 7°C; while on the warmer afternoons, the temperatures may rise to about 33°C, with the largest fluctuations occuring during the winter dry seasons (2).

The table below shows the monthly means of temperatures and rainfall:

Month	Mean Monthly temp., °C.	Average Monthly Rainfall in mm
January	19.8	23
February	19.6	47
March	20.0	105
April	20.2	134
May	19.6	125
June	18.6	96
July	17.9	119
August	18.3	201
September	18.9	202
October	19.1	120
November	19.2	98
December	19.4	55

The Thornthwaite Indices, Lang's Rain Factor and the DeMartonne Index were calculated for the Nioka Station. They are:

Thornthwaite PE = 81
Thornthwaite TE = 104
Lang's Rain Factor $\frac{P}{T} = 69$

DeMartonne Index $\frac{P}{1 + 10} = 49$

Another important feature of the climate is the prevalence of dry warm northerly or north-easterly winds during the dry seasons, occurring from November through to March. The lack of adequate rainfall during this period coupled with these drying winds is one of the factors to be considered in production of perennial crops in the area.

The climate is somewhat warner and drier in the northeastern part of the area. There is some decrease in the general elevation of the land surface in this direction, and also the annual average rainfall of West Nile region of Uganda (1) is only about 1000 mm. Thus from Nioka northeastward there is a slight decline in rainfall and an increase in temperature.

Geology and Soil Parent Material

The geology and geomorphology of the area and the origin and nature of soil parent materials have been covered in more detail by Dr. Ruge (12). A short resume is included in this report in order to better understand the genesis of the soils found. The following is a statement on the surficial deposits of the area: "The whole of Nioka area is mantled by translocated sediments. Nowhere within the area was a rock material found at the surface that had weathered in place. Translocated materials occur on all summits, slopes and bottomlands...As a result of translocation, surficial deposits are of heterogeneous composition and may not be related in the composition sense to the local bedrock they overlie. However, a definite correlation exists between the composition of the surficial sediments and the major rock associations and the various erosion surfaces.

"A common characteristic of the surficial sediments on all erosion surfaces and on all topographic positions whether summit, slope or bottomland is the basal gravel (stone line). Composition of the basal gravel may vary from complete hetereogeneity, i.e., a mixture of detrital laterite, basic rock, granitoid rock, metamorphic rock and vein quartz to almost complete homogeneity, i.e., a composition solely of vein quartz." The depth to these basal gravels is variable. In some cases these gravels may be at or near the surfaces while in other cases they may be overlain by several meters of reddish friable, permeable clayey material, some of which may carry appreciable sand.

The characteristics of the soil parent materials of the area are dependent on the nature of parent rock and on the subsequent processes of weathering translocation and mixing. In some cases the composition of surficial depostis has been strongly influenced by the rock association of the locality. In other cases the compositions have been influenced appreciably by translocation and mixing from nearby rock associations or by materials derived from rock associations that had covered the area previously.

Four major rock associations occur in the area:

1. A complex of granitoid rocks. This complex consists primarily of granitoid rocks with some inclusions of metamorphic materials. These rocks are most extensive in the central part of the area though they occur in other parts as well.

2. A complex of metamorphic rocks. This complex includes a variety of rocks such as sericite and mica schist, quartzite, quartzite schist, amphibole schist and gneiss. The most extensive occurrence is to the east of the granitoid association, but they are also found to some extent in the Shari River basin.

3. The materials derived from laterites as defined by Prescott and Pendleton (II). These materials which have been derived in part at least through breakdown of former laterite, cover much of the Shari basin. These materials are generally several meters deep and are generally fine textured.

4. Basic rocks. This association includes such dark basic rocks as dolerite and gabbro which occur as narrow localized dikes or outcrops.

Vegetation

A variety of vegetation is common to the area. In the undisturbed or but slightly-disturbed areas, the main cover consists of tropical grasses (savanna). Some native forest is likewise found in the area, but this occurs in small patches and is confined largely to the drainage-ways in the western part of the area. A large part of the area has been affected by native culture, so the vegetation in this case consists of a variety of post-cultural forms.

Several important grasses characterize the native savanna types. According to the botanists, a Loudetia arundinacea - Andropogon shirensis savanna is common in the eastern part of the area. The central portion and the western bornder area carries a Hyparrhennia cymbaria - Pennisetum purpureum savanna. Most of the Shari River area is covered by a savanna type characterized by Loudetia - Exotheca - Elionurus spp.

Where disturbance has been appreciable, these native forms of savanna have been replaced either by some post-cultural combinations of such grasses as Imperata, Setaria, Cymbopogon and Digitaria spp. and by forbs and brush.

The above is a very general resume of the findings of the botanists, Dr. Sperry (16) and Mr. Liben. It is suggested that their reports be consulted for more information.

Agriculture

Agricultural activities are carried on by both the European settlers and the natives. Of these two the area affected by the native agriculture is the more extensive. Outside of the upper Shari River basin, most of the area mapped has been utilized or is utilized by the natives for the production of native food crops and for grazing their livestock. Operations by the few European settlers are directed mainly to raising of cattle and to production of such crops as coffee, eucalyptus, geranium and quinine. Of these activities the raising of

cattle is the most extensive. The European settlers are concentrated in the north central and the southwestern parts of the area. The INEAC Station controls much of the land in the latter part.

Agricultural pursuits of the native population consist largely of the production of food crops, such as sweet potatoes, manioc, beans, maize, eleusine, Irish potatoes and some others in smaller quantities. All of these are consumed locally. The sweet potatoes and manioc form the major part of their diet and so are the most common of the crops grown. The practices are simple. A patch of land in the general vicinity of the village is cleared of grass or brush and then cultivated by hoe to form the seedbed. The crops are planted and some weeding operations are subsequently carried out. Two or three of these crops are raised on a piece of land, and then it is permitted to go back to grass or brush for several years before it is again brought under cultivation. This type of grass or brush fallow system of agriculture whereby several crops are grown and then the land is permitted to remain idle for several years (up to seven years or so), is most widespread. Results at the INEAC Station at Nioka tend to substantiate this system. It was found that yields dropped sharply after the second or third year but after the land has been in grass or brush fallow for several years, the yields assumed their normal level for another two or three years.

Livestock, mainly cattle (bahama) and goats, are reared by many of the native villages. Cattle raising by natives is particularly common in the eastern part of the area where herds up to about fifty head have been observed. Goats are common to all of the villages and appear to be used mainly as a medium of exchange. Cattle are sold or traded to the European settlers or dealers. There is no slaughtering of cattle by the natives, as a rule.

In addition to cattle and goats, some pigs and chickens are raised by the natives. These are sold to the Europeans in the area.

Grazing of cattle around the villages in some cases has created a problem of overgrazing with consequent soil deterioration. This is particularly serious in the Niagaki watershed area.

SOILS

The common upland soils of the area have a moderately acid relatively thick dark topsoil, an acid red upper subsoil, an acid darker reddish lower subsoil, and a red substratum Plate 1B. These several characteristics are particularly noticeable in the deeper well drained soils of the uplands in the area. They are the major soils of this region of higher elevations and though they have a fairly high organic matter content they would still fall into the Latosol suborder as defined by Kellogg (7). The dark reddish lower subsoil, the "dark horizon" is a particularly outstanding characteristic of these soils. According to analytical data available this characteristic appears to be due in part at least to the kind and quantity of organic matter present. These several characteristics set the well-developed upland soils apart from those of the lower regions. A tentative name, Humic Red Latosols is proposed for this Great Soil Group. Outside of these general similarities these soils show some differences in depth, texture and topography. Some areas are rocky or stony and some carry appreciable gravel in the subsoil. Further they differ in the nature of materials on which they have developed. This latter difference while not easily apparent is particularly important in the area.

Several other groups occur in association with this major group of soils. Some of these associated soils have developed on the shallower, coarser-textured materials commonly encountered on ridge tops and in places where considerable rock is exposed. Such soils generally have a fairly thick dark-colored topsoil of medium or coarse texture; a relatively-coarse-textured yellowish-red, or lighter-colored subsurface or upper subsoil; and a brownish or reddish-brown somewhat more clayey lower subsoil. These soils are developed only on the more porous, coarser-textured materials and are called Podzolic though it is realized that this deignation is not entirely satisfactory. They are of limited extent occurring in the more rocky or stony portions of the area, and are often associated with Lithosols.

Where the materials are extremely coarse-textured or rocky up to the surface, there has been little opportunity for good profile development. Generally a fairly dark topsoil is present, but otherwise there is little development of other horizons. Such soils are classed as Lithosols. They are rather limited in extent.

The remaining groups, the Hydromorphic soils, have developed under imperfect or poor drainage conditions. A common though inextensive group is encountered in the imperfectly-drained positions such as the lower and often gentle foot slopes and low benches along streams. These soils have a dark topsoil and a mottled subsoil and are classed as Gray Hydromorphic soils. The group of Hydromorphic soils developed under very poor drainage have been classed as Bog soils. They have a thick, dark topsoil that is high in organic matter over a gray subsoil that may or may not be slightly mottled.

In addition to the major soil groups listed there are fairly extensive marshy areas along many of the streams in the area. The residues of these marsh plants tend to accumulate as rae organic material in the water. Such areas have been mapped as Marsh.

Soils of the several groups mentioned often occur in close association on one landscape unit even though the mantle of soil parent materials is of one derivation from one common source. Furthermore, the distribution of these soils tends to follow a systematic pattern or sequence that is related to the topography of the landscape unit. The Lithosols and Podzolic soils are found most commonly on the sharper crests, shoulders or hilltops. The deep Latosols are found on the deeper materials on the more extensive summits or on the smoother slopes even though the slope gradient may be appreciable. Hydromorphic soils generally occur on the lower slopes and benches along the streams and drainageways. Such a sequence of soils, which Milne (9) has called a catena (lithologic variant) has been recognized on all of the major soil-forming materials of the area. Plate 1.

A full catena of soils has been recognized and identified on the material derived largely from granitoid rocks. Soils on the coarser materials in positions of excessive or somewhat excessive drainage are placed in the Libi, Pegno and Niagaki series. Libi series include the better developed Podzolic soils. This series often includes some of the Lithosolic soils that are associated with them. Soils of the Pegno series are likewise Podzolic but the development is less pronounced. The shallow Lithosolic soils found on the gravel-capped hilltops are placed in the Niagaki series. Latosol soils are included in the Rona and Aoda series. The soils of the Rona series have developed on materials of medium depth. Those of the Aoda series developed in deep materials. The Gray Hydromorphic soils are placed in the Loluda and the very poorly drained (Bog) soils in the Uswalo series.

A somewhat similar sequence of soils were identified on the materials derived from a complex of metamorphic rocks. In this catena the Luga and the Tshombe series include the soils developed on the moderately-deep and deep-mixed materials derived from these rocks. Soils developed on the somewhat more clayey materials derived largely from schists are placed in the Zeu series. The high surface soils are placed in the Setchama series. The Lithosols and the Podzolic soils are placed in the Niagaki and Pegno series, which also include the comparable soils on the granitic materials. Soils of the Libi series were not found on these materials. The Hydromorphic soils were placed in the Loluda and Uswalo series.

An important though inextensive sequence of soils occurred on materials derived to a large extent from the dark basic rocks. Generally the areas of these soils were too high and too dissected for hydromorphic conditions to obtain, so no soils of this category were identified. Lithosols and Latosol soils were present, however, and are included in this short catena. The Lithosols, which comprised the Ngumei series consisted of very dark reddish-brown topsoil with a shallow dark reddish-brown or reddish-brown subsurface in the gaps between boulders and blocks of rock. The Latosol soils were placed in the Djuda, the Djumali and the Gote series. Soils of moderate depth were placed in the first of these series. Of the deep soils, those with a dusky red and those with a red or dark reddish-brown solum were placed in the Djumali and the Gote series, respectively.

Much of the Shari River basin appears to have developed on materials that appear to have come in part at least from laterite. The materials are generally deep so the Latosol soils cover a large part of the area. The Lithosols are placed in the Munzi series and are confined largely to a few hilltops and to some of the sharper valley breaks and shoulders bordering some of the streams and drainageways. The shallow to moderately-deep soils on this material are placed in the Golu series. The deep Latosol soils that are relatively free from medium or coarse quartz sand are included in the Shari and the Dadwoda series. The first of these have a dusky red solum and generally occur on the gently-sloping summits, while the second series include soils having a brighter red solum which are found on slopes as a rule. The soils of the Mboro and Kampala series are similarly related and differ from the Shari and

Dadwoda soils in that they carry noticeably more medium or coarse quartz sand. The Latosol soils developed under gallery forest on these materials are placed in the Dzaga series and are included in the catena.

The Humic Red Latosol Soils

The altosol soils have a number of characteristics that are rather consistent in their presence. Their thick moderately acid topsoil (A_1 horizon) is of a very dark color which, depending on the parent material and previous use history of the soil, may be black, very dark gray, reddish black or dark reddish brown. It generally has a loamy feel despite the high clay content (up to about 60 per cent) is some cases and has a weak to moderately developed granular or crumb structure. This surface soil loses some of its dark color below the 15 or 20 centimeter depth grading through a dark reddish brown subsurface to terminate with a rather clear boundary at about 40 cm. It merges rather quickly into the reddish upper subsoil, the B_1 horizon of this depth. Under forest the topsoil is generally not as dark being a reddish brown or a lighter shade of dark reddish brown. In most cases the B_1 horizon may have a slightly higher clay content than the one above and is friable as a rule. It is generally acid (pH around 5) and has a weak to moderately-developed fine or medium subangular structure. At about 80 centimeters it begins to assume a slightly darker color to merge into the rather distict, comparatively darker subsoil (B_2 horizon) at a depth of about one meter. This is the "dark horizon" of Smeyers (14) who was probably one of the first to recognize this characteristic. It is one of the outstanding morphological characteristics of the Latosol soils of the region. This dark subsoil attains its maximum development somewhere between the one and two meter depth, taking on a color that may range from reddish brown or dark red to dusky red or dark reddish brown. (Plate 1B) It has about the same acidity and texture as the B_1 horizon but is generally even more friable and tends to have a weak fine crumb or very weak subangular structure. It has been observed often that there is a tendency for the roots to be somewhat more numerous and to assume a more lateral development in this horizon, especially in the upper part. The dark color of this horizon begins to taper off in the lower part and grades into a friable, distinctly-brighter reddish transition or parent material horizon at about two meters or somewhat deeper. The B and C horizon boundaries are gradual or diffuse.

Another notable characteristic of these soils is the prevalence of moderately friable to firm aggregates or pseudo concretions in the subsoil. These structure units or soil masses are similar to the surrounding soil in color though in some cases they are darker. They are less friable than the soil matrix and have a subangular blocky or subrounded form of about the same size as the normal structure units. The size designation used in describing these units is comparable to that of the subangular or angular blocky. When examined under a hand lens these aggregates appear to be made up of, or are weakly cemented by, dark mucilaginous or colloid-like material. Examination of soil in place shows that some of this material coats other normal soil aggregates and also some of the other structure unit surfaces. These aggregates appear to be most numerous in the B_2 horizon though they are also common in B_3 horizon in many cases. Frequently these aggregates give way to small (1 cm. in diameter) subrounded or road moderately firm to firm aggregates or pellets in the B_3 and C horizons.

The thickness of the solum or rather the depth to which profile development can be recognized morphologically appears to be roughly about two and one-half meters. Below this depth the profile assumes and maintain uniform characteristics of color, texture and consistence to various depths, depending on the thickness of parent material. In the Nioka area the parent materials are reddish in color and have a clayey or loamy texture and a frianble consistence.

The soils are easily permeable as indicated by the high degree of porosity. Smeyers (13) measured the porosity of a number of soils in the Nioka area to a depth of about one and one-half meters. A total porosity of about 75 per cent was found in the dark surface soil in most cases. Least porosity, generally in neighborhood of 60 per cent was encountered in the upper reddish subsoil at the 45 to 60 centimeter depth. Volume-weights ranged from 0.66 in the dark A_1 horizon to a maximum of about 1.20 in the reddish subsoils (B_1 horizon).

Influence of Topography

Topography is a factor in the nature and intensity of development of the "dark horizon". On the nearly level or gentle slopes, usually those with a gradient of less than about 5 per cent, the B_1 horizon is somewhat less distinct than it is in soils of the steeper positions. On these gentle slopes such as those found on the summits of the large hills,

the solum shows less variation between the B_1 and B_2. The subsoil usually has a pronounced dark reddish brown or dusky red to a depth of about two meters or more. The B_1 horizon while perceptible is not as thick and is darker than it is on steeper slopes. On the more sharply convex shoulders and upper slopes the "dark horizon" is less intensely developed and the profile in general shows a brighter reddish color throughout. Positions such as these appear to be the driest part of these landscape unit. The "dark horizon" is often most noticeable on the lower slopes. Here the B_2 horizon is a pronounced dark reddish brown or dusky red which shows up in sharp contrast to the red B_1. Analyses often show a noticeable increase in organic carbon content in B_2 over that of the B_1 horizon.

Parent materials (C horizon) likewise show some topographic influences. On the nearly level or gently sloping areas the materials are usually a red or dark red. Downslope however the dark red or red gives way to some yellowish influence so that the color of the parent on the lower slopes is often yellowish red.

The reaction of the surface soil appears to be influenced to some extent by topography. Of the various profiles samples collected in the area for analyses the pH of the surface samples from the nearly level or gently sloping areas is higher than that of comparable horizons from the slopes.

Nomenclature of Horizons in the Humic Red Latosol Soils

The Latosol soils of the region have profiles with rather pronounced horizon development. As stated previously, the characteristic profile has a dark surface soil about 40 centimeters thick, a reddish upper subsoil of about the same thickness, an appreciably darker reddish lower subsoil that reaches a depth of about two meters and, underneath that, an indefinite zone of bright reddish parent material. In terms of the ABC nomenclature, the dark surface horizon is designated as A horizon, the reddish upper subsoil and the darker reddish lower subsoil as B and the parent material as C. These broad horizons may be subdivided into subhorizons. Definitions and descriptions of each of the horizons and subhorizons are presented in order to clarify their use in the region:

The A_1 horizon: This includes the entire thickness of the strongly developed dark surface ~~soil. It is a~~bout forty centimeters thick, and where it has not been disturbed under savanna, consists of three subhorizons, viz:

- A_{11}: The upper part - a zone of black, very dark gray, reddish black, very dark reddish brown or very dusky red soil with a crumb or granular structure.
- A_{12}: The middle part - relation to A_{11}, it is a horizon somewhat lighter in color, being a very dark gray, very dark reddish brown, dark reddish brown or dusky red. It often has a somewhat coarser but less-developed structure than A_{11}.
- A_{13}: The lower part - this subhorizon is a further gradation of the dark topsoil and acts as a transition between the dark surface soil and the reddish upper subsoil. The color is a dark reddish brown, dusky red, dark red or reddish brown. It terminates with a rather clear boundary at about the 40 centimeter depth.

The B horizon: This thick, well developed master horizon includes the reddish upper subsoil and the appreciably darker reddish lower subsoil which generally extends to a depth of about two and one-half meters. The component horizons and subhorizons as identified in the area include the following:

- B_1: The upper reddish subsoil - this horizon because of its brighter reddish color stands out in contrast between the A_1 horizon and the darker reddish B_2 horizon below. Its thickness is about forty to sixty centimeters, although this is variable, being somewhat less, as a rule, on the more gentle slopes. The clay content is generally slightly higher than in the A horizon, while the structure is weakly subangular. Often the lower transition part is somewhat darker. If this transition is described separately, it is designated as B_{12} and the upper part as B_{11}.

- B_2: The lower darker reddish subsoil - the "Dark horizon" - this horizon which starts with a gradual or diffuse boundary, at a depth of about one meter, is generally sufficiently darker than the horizons above or below to be recognized rather easily. The color in the moist state ranges from reddish brown

or dark red to dark reddish brown or dusky red. Usually the texture is similar to that of B_1, but the subangular structure is inclined to be more crumbly and porous. The maximum dark color development occurs somewhere between the one and one and one-half meter depths and this has been designated as B_{21}. Few to numerous, moderately-firm subangular to rounded clayey aggregates or pseudo-concretions of varying sizes are encountered in this horizon. They are of about the same color as the soil. The next subhorizon down, the B_{22}, which is the lower part of B_2, is still relatively dark though it may be somewhat lighter than the B_{21}. It has a somewhat less crumbly structure. The moderately-firm pseudo-concretions or aggregates appear to be more numerous, as a rule. The lower part of this horizon loses its dark color progressively to terminate in a rather diffuse boundary somewhere around the two meter depth. The next horizon is the B_3.

B_3: The lower transition horizon of the solum. The color resembles that of the parent material, being red, dark red, reddish brown or yellowish red. It is included in the soil profile, however, because of the structure and consistence and the relatively-abundant pseudo-concretions or moderately firm aggregates. They have a color similar to that of the soil but appear to be smaller and more rounded than in the horizons above. The structure is still weakly developed subangular; but the consistence is somewhat more firm, being friable or moderately friable. This horizon terminates in a diffuse zone at about the two to two and one-half meter depth to merge into the friable parent material, C horizon, of about the same color.

<u>The C horizon</u> (parent material): This is a horizon of indefinite depth and in this area it includes frequently the material below the soil profile and above the stone line or the weathered parent rock. The materials encountered generally have a red, dark red, reddish brown or yellowish red color. Where the stone line is encountered in the B_2 horizons, the material underneath is still identified as the B or C horizon. If it occurs in the B_3 horizon or lower, it is not considered as parent material but is referred to as the D horizon.

<u>The D horizon</u>: The weathered parent rock, the stone line or the material beneath the stone line if encountered in the B_3 horizon or lower.

<u>Ap</u>: The depth or horizon disturbed or mixed appreciably by cultivation.

<u>u</u> : A subscript used to identify the stone line or the material underneath the stone -line: e.g., B_{2u}, B_{3u}, C_u, etc.

A description of Mboro clay loam moderately-eroded phase together with some analytical data is given as an example of Humic Red Latosol soils. This profile (No. 678) was collected in the west Shari River area:

Location: West Shari River area
Position: Nearly level summit about 100 meters wide
Vegetation: Loudetia savanna

A_{11} 0-13 cm. Black clay loam 5 YR 2/1 2/2 (moist). 5 YR 3/2 (dry). Moderately-developed medium granular structure. Fine roots abundant.

A_{12} 13-27 Very dusky red clay loam 2.5 YR 2/2 2/4 (moist). 2.5 YR 3/2 3/4 (dry). Weakly-developed coarse granular structure. Roots abundant. Very friable.

A_{13} 27-39 Dark reddish brown clay loam. 2.5 YR 2/4 (moist). 2/5 YR 3/4 4/4 (dry). Moderately-well-developed fine subangular or coarse granular structure. Friable. Fine roots numerous.

B_{11} 39-74 Dark red clay. 2.5 YR 3/6 (moist). 2.5 YR 4/6-3/6 (dry). Weakly-developed fine to medium soft subangular structure. Occasional moderately-firm aggregates. Upper boundary clear, lower diffuse.

B_{12} 74-94 Dark reddish brown clay. 10 R 2.5 YR 3/4 (moist). 2.5 YR 3/6 (dry). Somewhat darker than horizon above. Weakly-developed fine to medium subangular structure. Friable, soil breaking easily to weakly-developed fine crumb. Roots common. Lower boundary diffuse.

B_{21} 94-134 "dark horizon". Dusky red clay. 10 YR 3/4 (moist). 2.5 YR 3/6 (dry). Weakly developed fine to medium subangular structure. Friable, breaking up easily to weak fine crumb. Some moderately-firm dark reddish brown aggregates. This horizon is somewhat more firm in place than B_{22}. Boundaries diffuse.

B_{22} 134-185 "Dark horizon". Dusky red clay 10 R 3/4 3/3 (moist). 2.5 YR 3/6-4/6 (dry). Weakly-developed fine to medium subangular structure. Porous, friable, breaking easily into weak fine crumb. Some moderately-firm dark reddish brown aggregates. Roots common but show appreciable lateral spreading. Boundaries diffuse.

B_3 185-250 Dark red clay 10 R 3/6 (moist). 2.5 YR 4/6 (dry). Very weakly-developed fine to medium subangular structure. Friable breaking easily to very weak fine crumb. Some roots present. Lower boundary indefinite.

C 250-620 Dark red clay 10 R 3/6 (moist). 2.5 YR 10 R 5/8 (dry). Very friable.

D_u 620-700 "Stone line". Dark red clayey material, red when dry, mixed quartz grit and detrital laterite pebbles.

D_u 700-820 Weathered rock material. Mixed gray, white, yellow and yellowish red material brought up by auger.

Analyses of Profile No. 678 - Mboro clay loam, moderately eroded phase

(Data by INEAC - Yamgambi)

Horizon	Depth (cm)	Clay 2 u	Silt 2-50u	Sand 50-2000u	pH	Carbon %	Nitrogen %	Exchangeable bases ME/100 grs.	Exchangeable calcium ME/100 grs.	T value pH 6.7	T value pH 5.1
A_{11}	0-13	67.8	9.7	22.5	5.4	3.07	0.209	9.1	4.0	11.7	10.1
A_{12}	13-27	66.2	8.2	25.6	5.1	2.41	0.151	4.0	1.3	9.9	8.4
A_{13}	27-39	66.0	8.4	25.6	5.0	1.69	0.108	4.1	0.7	7.4	6.1
B_{11}	39-74	68.8	8.8	22.4	5.0	1.01	0.048	3.8	1.3	6.3	4.8
B_{12}	74-94	68.0	8.4	23.6	4.9	0.77	0.044	3.7	0.5	7.2	5.3
B_{21}	94-134	68.3	7.8	23.9	5.0	0.71	0.047	3.9	0.8	6.7	5.9
B_{22}	134-185	69.1	7.6	23.3	5.0	0.61	0.030	4.4	0.8	6.5	5.0
B_3	185-250	67.7	8.4	23.9	5.1	0.49	0.031	4.6	0.6	5.4	3.9
C	250-300	66.66	10.1	23.3	5.2	0.26	0.022	4.5	0.7	4.8	3.4
	300-400	65.3	12.1	22.6	5.1	0.19	0.015	4.6	1.2	4.4	3.4
	400-500	65.4	13.6	21.0	5.2	0.13	0.012	4.9	1.4	3.9	3.2
	500-620	62.3	18.0	19.7	5.5	0.12	0.014	5.1	1.3	5.2	3.7
D_u	620-700	46.9	23.5	29.6	5.4	0.10	0.018	3.7	1.0	3.6	
D_u	700-820	24.4	44.8	30.8	5.2	0.09	0.015	2.2		3.1	

Designation of Soil Horizons of Humic Red Latosol Soils Under Forest

The soils under forest in this region show somewhat different characteristics in the A horizon. It was observed that generally there is a thin cover of slightly-altered leaf litter on the surface. Under this there is a thin horizon of semi-decomposed litter and underneath that a thin horizon of mull composed of mixed decomposed litter and mineral soil. The A_1 horizon proper is not as dark as that under savanna, generally being a somewhat uniform reddish brown, dark brown or dark reddish brown. The horizon designations used for soils under forest are:

The A_0 horizon: This includes the surface horizons composed primarily of the organic matter derived from forest litter in various stages of decomposition. Generally three subhorizons are recognized:

A_{00}: Forest litter, mainly leaves - not appreciably affected by decomposition. Generally thin (2 to 5 cm.)

A_0 : Semi-decomposed forest litter - the litter materials that have been broken down to small fragments and have taken on a brown or dark brown color. Less than two centimeters thick as a rule.

$A_0/1$: Mull - a thin horizon, about two centimeters pr less of mixed dark organic materials and mineral soil. Crumb structure.

The A_1 horizon: This horizon in soil under forest includes the relatively thick (about 40 cm.) reddish brown, dark brown or dark reddish brown surface soil. The upper part is often somewhat lighter in color and has been designated as the A_{11} horizon. The lower part is A_{12}.

The B and C horizons under forest are designated similarly to the comparable horizons in savanna soils.

A description of Dzaga clay loam is presented to show the morphology of the Iatosol developed under forest in the Nioka area. The soil profile was collected in a gallery forest in one of the drainageways in west Shari River area. Analytical data available are also included:

Soil description of (Profile No. 681): Dzaga clay loam.

A_{00}	3-0 cm.	Leaf litter, partially decomposed.
A_1/o	0-2	Dark reddish brown mull (5 YR 3/3) with fine crumb structure. Many fine tree roots spread horizontally.
A_{11}	2-30	Dark reddish brown clay loam. 5 YR 3/3 4/3 (dry). Moderately-well-developed crumb structure. Roots abundant.
A_{12}	30-45	Dark reddish brown clay loam 2.5 YR 2/4 3/4 (moist). 5 YR 3/4 4/6 (dry). Very weakly-developed fine to medium subangular structure. Very friable, breaking down into very weak fine crumb. Roots common.
B_1	45-96	Dark reddish brown clay 10 R 2.5 YR 3/4 (moist) 2.5 YR 4/4 3/6 (dry). Very weakly-developed fine to medium subangular structure. Soft friable consistence, breaking down easily into weak fine crumb. Roots common.
B_{21}	96-168	Dusky red clay 10 R 3/4 (moist) 2.5 YR 3/4 4/4 (dry). Very weakly developed fine to medium subangular structure. Friable, some moderately-firm aggregates. Roots common.
B_{22}	168-200	Dark red clay 10 R 3/6 4/6 (moist) 2.5 YR 3/6 4/6 (dry). Very weakly-developed fine to medium subangular structure. Friable. Some moderately-firm aggregates. Some fine roots.

B_3 200-250 Dark red clay 10 R 3/6 4/6 (moist) 2.5 YR 5/6 4/6 (dry). Very weak fine to medium subangular structure. Friable. Moderately-firm aggregates present. Roots few.

C 250-440/ Red clay 10 R 4/6 (moist) 2.5 YR 5/8 4/6 (dry).

Analyses of Profile No. 681 - Dzaga clay loam

(Data by INEAC - Yangambi)

Horizon	Depth (cm)	pH	Carbon %	Nitrogen %	Exchangeable bases ME/100 grs.	Exchangeable calcium ME/100 grs.	T values pH 6.7	T values pH 5.1
A_1/o	0-2	5.1	12.35	0.772	20.2	14.2	24.0	20.8
A_{11}	2-30	5.2	2.85	0.249	8.5	5.1	10.9	8.5
A_{12}	30-45	5.0	1.23	0.077	3.9	0.5	7.7	6.2
B_1	45-96	5.2	0.98	0.059	4.0	0.5	7.7	5.5
B_{21}	96-168	5.1	0.87	0.035	3.9	0.5	7.8	5.8
B_{22}	168-200	5.1	0.64	0.030	4.1	0.9	7.8	5.2
B_3	200-250	5.1	0.32	0.021	4.5	0.8	5.6	3.8
C	250-440	4.8	0.16	0.013	4.3	0.6	4.1	3.3

The Podzolic Soils

This group includes the upland soils having a subsurface that is appreciably lighter colored than the rest of the soil profile. These soils have developed on somewhat coarse-textured or shallow, gravelly materials found on the upper slopes and ridges or summits and on the rocky hilltops where considerable freshly-weathered material high in very coarse quartz sand is present. Plate 1A. Such a combination of steep slopes and porous materials tends to create a site of excessive or moderately-excessive drainage. Considerable lateral downslope movement of water or leaching in the upper solum appears to take place in this kind of material. They are called "podzolic" because of the lighter color and coarse texture of the A_2 horizon and the darker reddish color and higher clay content of the B. The vegetation is savanna with Loudetia spp. being a common species.

The very dark gray or black topsoil (A_1 horizon) is of a light loamy texture and often about thirty centimeters thick. Beneath this horizon the soil becomes appreciably lighter in color and may be anything from a light yellowish brown to yellowish red or reddish brown. This is the A_2 horizon. As a rule, there is considerable quartz in this horizon which imparts a gritty feel despite the varying quantities of loamy or clayey material in the matrix. Larger fragments of rock may be present and may occur as a stone line or be distributed throughout the horizon. The clayey or loamy matrix material tends to become more prevalent below a depth of about seventy centimeters and, in addition, the color tends to become a somewhat darker red or reddish bornw. The maximum in this loamy or clayey texture and the darker reddish color is reached somewhere between the 100 and 150 centimeter depth. This constitutes the B horizon. Below this horizon the color becomes lighter again and at a depth of about 200 centimeters the material is mainly weathered rock streaked with reddish or brownish materials from above. This is the C horizon. Each of these major horizons may be subdivided further into sub-horizons.

A description of Libi loam is included as an example of these "podzolic" soils. This profile was sampled on granite-capped ridge in the Mt. Rona area. Elevation is 1754 meters:

Libi loam (Profile No. 611):

A_{11}	0-12 cm.	Very dark gray gritty loam 5 YR 3/1 4/1 (moist) 5 YR 3/1 4/1 (dry). Weakly to moderately-developed granular structure. Roots abundant.
A_{12}	12-35	Dark reddish gray, gritty loam 5 YR 4/2 (moist). 5 YR 3/2 4/2 (dry). Weakly-developed coarse granular structure. Roots abundant.
A_{21}	35-50	Vein quartz fragments mixed with light-colored gritty material.
A_{22}	50-75	Yellowish-red gritty sandy loam. 5 YR 4/8 (moist). 5 YR 4/4 (dry).
A_3	75-105	Reddish-brown gritty sandy loam. 5 YR 4/3 (moist). 10 YR 6/4 7/4 (dry).
B_1	105-155	Yellowish-red gritty loam. 5 YR 4/8 (moist). 7.5 YR 6/6 7/6 (dry).
B_2	155-220	Yellowish-red gritty loam. 5 YR 4/8 (moist). 7.5 YR 6/6 5/6 (dry). Red clay streaks present.
C_1	220-325	Yellowish-red micaceous clay loam. 5 YR 4/6 (moist). 7.5 YR 6/6 (dry).
C_2	325-400	Yellowish-brown weathered rock material 10 YR 6/4-5/4 (dry).

Analyses of Libi Loam (Profile No. 611)
(Data by INEAC - Yangambi)

Horizon	Depth (cm)	Clay 0-2u	Silt 2-50u	Sand 50-2000u	pH	Carbon %	Nitrogen %	Exchangeable bases ME/100 grs.	Exchangeable calcium ME/100 grs.	T value pH 6.7
A_{11}	0-12	27.6	18.8	53.6	5.5	1.87	0.184	6.6	4.0	9.1
A_{12}	12-35	25.5	15.8	58.7	5.1	0.78	0.110	3.2	1.2	6.5
A_{21}	35-50	13.9	13.9	72.2	- -	0.36	- - -	2.5	- -	- -
A_{22}	50-75	13.9	18.6	67.5	4.7	0.11	0.027	2.3	- -	3.5
A_3	75-105	7.1	11.3	81.6	5.3	0.08	0.026	1.9	- -	2.4
B_1	105-155	17.6	17.5	64.9	5.1	0.12	0.023	2.7	- -	4.5
B_2	155-220	22.0	28.4	49.6	5.2	0.25	0.026	3.4	0.8	4.6
C_1	220-325	18.1	24.9	57.0	5.3	0.13	0.015	3.0	1.0	- -
C_2	325-400	11.9	30.6	57.5	5.5	0.13	0.034	3.0	- -	- -

The Lithosols

In places where the hard rocky, gravelly, or cemented material is at or close to the surface and where the drainage is excessive, the soil profile consists primarily of a dark topsoil (A_1 horizon) over these hard, partially-disintegrated or weathered materials (C or D horizontal). Some weak development of a lightly lighter colored A_2 and reddish or yellowish-red B horizons may be noted in the gravelly materials, and in this case the soil may be considered to be weakly podzolic. Soils of this category are classed as Lithosols. These soils are of limited extent in the area.

The nature of parent material has determined or strongly influenced the characteristics of these soils. Those in the western part of the area developed on materials derived from grantoid rocks or laterite are generally more acid than those of the eastern part of the area, the latter soils being slightly acid or neutral. As an example of the Lithosol, a description and analyses of Niagaki gravelly loam are given:

Niagaki gravelly loam (Profile No. 524):

Location: 2 kilometers southwest of Tshombe Mission
Position: Gently-sloping (about three per cent) summit about seventy-five meters wide.
Vegetation: Mixed grasses

A_{11}	0-16 cm.	Black gritty loam 5 YR 2/1 (moist) 5 YR 3/1-2/2 (dry). Moderately developed fine crumb structure. High content of quartzite pebbles and fragments. Roots abundant.
A_{12}	16-25	Dark reddish brown stony loam. 5 YR 3/2 (moist). 5 YR 3/2 3/3 (dry). Many quartzite fragments up to 5 cm. across. Roots abundant.

Analyses of Niagaki Gravelly Loam (Profile No. 524)
Analytical data by INEAC - Yangambi

Horizon	Depth (cm.)	Clay 2 u	Silt 2-50 u	Sand 50-2000 u	Material above 2 mm	pH	Carbon %	Nitrogen %	Exchangeable bases ME/100 grs	Exchangeable calcium ME/100 grs
A_{11}	0-16	29.3	20.2	50.5	46.2	7.0	2.32	0.307	22.3	12.9
A_{12}	16-25	30.5	15.5	53.5	75.3	6.8	1.49	0.209	12.2	6.1
B	25-50	10.0	7.8	82.2	82.3	6.8	0.10	0.030	2.7	1.6
B	50-85	25.1	14.0	60.9	77.5	6.8	0.15	0.037	4.4	- -
D	85 +	20.9	17.0	54.0	75.3	6.6	0.11	0.031	3.3	- -

B	25-50	Reddish-brown gritty material 5 YR 4/3 (moist) 5 YR 4/4 (dry). Material mainly quartz grit up to about 4 mm in diameter. Roots common but less abundant than in horizon above.
B	50-85	Reddish-brown gritty clayey material 5 YR 4/4 (dry). The gritty clayey materials occupy the spaces between the large quartzite fragments.
D	85+	Partially-weathered quartzite, with reddish clayey material in cracks.

*SEE PAGE 13-A

The hydromorphic Soils

This category includes soils that have developed under conditions of imperfect or poor drainage. Where only the lower solum was affected by such conditions, the soil profile may differ but little from that of the Humic Red Latosol soils, being mottled or having some red or black concretionary material in the lower B horizon. Such soils would be classed as being moderately well drained; but since they occurred only in very narrow zones along the drainageways, no separate category was established. Generally they occupied strips less than thirty meters in width so were too limited to map.

Where the zone of imperfect or poor drainage rose higher in the solum, markedly different soil profile characteristics were observed. Imperfect drainage, i.e., a situation where the zone of fluctuating free water in the soil may produce wet conditions for appreciable periods and thus lead to development of a grayish or yellowish-brown, often mottled solum. Such soils were classed as Gray Hudromorphic. Plate IC. Soils of this group have a very dark gray topsoil (A_1 horizon) which may be up to about forty centimeters thick. The next horizon down, the A_2, is generally grayish brown, yellowish brown and may show some mottling. The B horizon is more firm than the other horizons, is somewhat higher in clay and is generally strongly mottled. The mottled grayish parent material, C horizon, is encountered at a depth of about two meters or somewhat deeper. Each of the main horizons, mentioned, may be subdivided into subhorizons. A subscript, "g", is used to indicate some gleying.

Poorly or very poorly-drained soils are encountered rather frequently along some of the streams and on the bottomlands of most of the drainageways. Free water is present within one meter of the surface most of the year in these situations. Such conditions produce a soil with a thick black or very dark gray topsoil with a high content of mucky organic matter.

The subsoil is gray and strongly gleyed and may or may not be somewhat mottled. These are classed as Bog soils. Plate 1D. It is difficult to apply the ABC nomenclature of horizons to these soils. The horizons are numbered H1, H2, H3, and so on for the horizons high in organic matter while "G" identifies the strongly-gleyed horizons.

Examples of Gray Hydromorphic soils and of Bog soils are given below together with descriptions and analyses:

Gray Hydromorphic Soils (Loluda loam), Profile No. 526:

Location: 2 kilometers southwest of Tshombe Mission
Position: Lower foot slope (about 8%) bordering drainageway
Vegetation: Hyparhennia, Digiteria spp. Some Pennisetum sp. nearby

A_{11}	0-16 cm.	Black loam. 7.5 YR 2/0 (Moist) 7.5 YR 3/0 (dry). Moderately developed medium to coarse granular structure. Upper five centimeters are moderately developed fine crumb.
A_{12}	16-30	Very dark gray clay loam 7.5 YR 3/0 (moist) 7.5 YR 3/0 4/0 (dry). Weakly-developed coarse granular structure, appears to be somewhat massive in comparison to horizon above.
A_{2g}	30-45	Dark grayish-brown clay loam 10 YR 4/2 (moist) 10 YR 4/2 5/2 (dry). Dark yellowish-brown mottling 10 YR 4/4 (moist). Weakly-developed fine to medium subangular structure. Friable. Clay appears to be micaceous.
A_{3g}	45-82	Dark yellowish-brown clay loam 10 YR 4/4 (moist). 10 YR 5/4 (dry). Mottled with yellowish brown and yellow. Weakly-developed fine to medium subangular structure. Roots common. Clay appears to be micaceous.

B_{1g}	82-122	Clay mottled with reddish yellow, yellowish brown and light yellowish brown (moist). Mixed sample 10 YR 5/6-6/4 (dry). Weakly-developed fine to medium subangular structure. Friable. Soil becoming more firm in lower parts. Roots increasing.
B_{2g}	122-150	Clay mottled gray, grayish brown and yellow on 10 YR chart (moist) 10 YR 6/4 mottled with 10 YR 6/8 (dry). Well-developed fine to medium subangular structure. Firm in place but friable when removed. Fewer roots than in horizon above.
B_{2ug}	150-160	Mottled clayey matrix mixed with sharp angular quartzite fragments. Very firm in place. 10 YR 5/6 6/6 (dry).
B_{3g}	160-220	Clay mottled gray and yellowish brown. 10 YR 6/1 and 10 YR 5/8 - 7.5 YR 6/8 (dry). Slightly sticky and plastic. Highly micaceous.
C	220-300	Gray micaceous material brought up by auger. Streaked with white. Water at 230 centimeters.

Analyses of Profile No. 526 - Loluda loam
(Data by INEAC - Yangambi)

Horizon	Depth (cm)	Clay % 2 u	Silt % 2-50 U	Sand 50-2000u	Material 2 mm %	pH	Carbon %	Nitrogen %	Exchangeable bases ME/100 grs	Exchangeable calcium ME/100 grs
A_{11}	0-16	45.1	19.9	34.9	- -	6.1	4.40	0.400	23.7	14.9
A_{12}	16-30	40.3	17.7	41.9	- -	5.6	2.35	0.247	13.3	8.6
A_{2g}	30-45	34.6	20.2	44.9	- -	5.5	1.17	0.110	6.9	3.6
A_{3g}	45-82	38.0	23.1	38.9	2.4	5.4	0.48	0.065	6.0	3.1
B_{1g}	82-122	50.0	19.9	31.0	- -	5.4	0.42	0.059	7.9	3.3
B_{2g}	122-150	46.1	22.4	31.5	- -	5.6	0.28	0.046	9.7	4.2
B_{2ug}	150-160	38.9	23.0	38.1	64.2	5.9	0.15	0.032	9.5	3.7
B_{3g}	160-220	33.2	29.1	37.7	13.2	5.8	0.07	0.015	10.7	4.5
C	220-300	13.1	40.1	46.8	5.5	6.4	0.05	0.008	9.9	4.2

A description and analyses of Uswalo muck (Profile No. 634) is given below as an example of Bog soil:

Location:	About 5 kilometers east of Luga Mission, 600 meters southwest of Protestant Mission School House.
Position:	Level poorly-drained stream bottom about 75 meters wide.
Vegetation:	Cultivated. Portatoes (Irish), corn.

H_1	0-20 cm.	Black muck. 2.5 YR 2/0 (moist). 7.5 YR 2/0 (dry). Good fine crumb structure.
H_2	20-30	Black muck 10 YR 2/0 2/2 (moist). 7.5 YR 3/0 4/0 (dry). Tends to be massive but breaks up into porous chunks. Many partially-decomposed (brown) roots.
H_3	30-56	Black mucky material 10 YR 2/1 (moist) 7.5 YR 5/0-4/0 (dry). Massive. Stained yellowish brown or brown by fine roots.
G_1	56-75	Olive gray fine sand. 5 Y 6/2 5/2 (moist). 5 Y 7/2-8/2 (dry). Moderately firm in place. Some partially-decomposed roots (brown) present.
G_2	75-85	Light olive gray sandy clay loam. 5 Y 8/2 (dry). Massive, moderately plastic. Carries some quartz pebbles.
G_3	85-110	Olive gray sand mixed with subrounded quartz and quartzite fragments. 5 Y 6/2 (wet) 5 Y 8/2 (dry). Water at 85 cm.

Analyses of Profile No. 634 - Uswalo Muck
(Data by INEAC - Yangambi)

Horizon	Depth	pH	Carbon %	Nitrogen %	Exchangeable bases ME/100 grs.	Exchangeable calcium ME/100 grs.	T value pH 6.7	T value pH 5.1
H_1	0-20	5.6	6.23	- -	24.4	15.9	53.4	47.7
H_2	20-30	5.5	6.20	0.649	23.3	15.5	40.9	28.7
H_3	30-56	5.4	3.08	θ.256	10.9	7.6	17.7	14.7
G_1	56-75	5.4	0.24	0.012	2.0	- -	2.6	1.8
G_2	75-85	5.9	0.17	0.010	5.7	3.7	7.0	5.6
G_3	85-110	5.9	0.08	- -	2.6	- -	3.0	2.1

SOIL SURVEY PROCEDURES

The soils of the area were classified on the basis of those characteristics that could be observed in the field and also on the basis of data obtained in the laboratory. They were classified into series, types and phases. A soil "series" is defined (15) as "a group of soils having soil horizons similar in differentiating characteristics and arrangement in the soil profile, except for the texture of the surface soil and developed from a particular type of parent material. The soils within a series are essentially homogeneous in all soil profile characteristics except texture principally of the surface horizon and in such features as slope, stoniness, degree of erosion, topographic position and depth to bed rock, where these features do not modify greatly the kind and arrangement of soil horizons". Each soil series is named, the name coming from some geographic location in the area where the particular series was first identified and described. Thus a series which was first identified in the Rona area was called Rona series.

A soil series is further subdivided into soil types. A soil type includes all those soils that are similar not only in the soil series characteristics but are also similar in the texture of the A horizon or surface soil. In the area mapped, there was not sufficient variation in the surface textures of soils of one series so only one type was identified in each series. The name of a soil type includes the series to which it belongs and also the texture class of the topsoil; e.g., Rona loam.

Significant variations in degree of erosion, slope or stoniness of a soil type are shown as a phase of this category. Thus a moderately-eroded Rona loam soil is identified as "Rona loam, moderately-eroded phase". Slope phases are used to identify variations in slope class that is common to the particular soil type.

Regular semi-detailed and some detailed soil mapping operations followed the preparation of the preliminary legend. The field procedure used was to examine each landscape unit, such as a large hill or an interfluve by making several borings and if deemed necessary by digging pits in selected locations. All of the main descriptions were made from pit exposures. It was discovered during the preparation of preliminary legend that in general the solum reached a depth of about two to two and one-half meters so both the pits and borings were of this general depth. Some deeper borings were also made. The frequency of boring depends to some extent on the complexity of the area. Generally one boring was made for an area of about twenty to thirty hectares. In more complex areas, it was more frequent; while in more uniform areas, such as the Shari basin, the examinations were at greater intervals. In addition to these deeper borings and pits, more frequent examinations of the topsoil and upper subsoil were made by using a spade and a one and one-half meter auger. Several such examinations were made within a radius of about 100 meters of the deeper borings and pits. When adequate equipment was available, a crew of seven to nine native helpers were used. Generally two or three were used on each of the two deep augers, two were digging pits and one or two accompanied the pedologist while making the soil examinations with smaller auger and spade. Deep auger borings were laid out in sequence for examination by the pedologists. It took about twenty minutes to make a 225-centimeter boring if the auger was in good shape. After the native helpers gained some experience, they were able to pick suitable locations for borings on their own and lay out the soil samples for examination by the pedologist. No set traverses were followed. Where possible native paths were used to get into the larger areas and then shorter trips were made from these into areas to be examined.

In addition to routine and generally-short field notes, more detailed examinations and descriptions were made on pit dug at suitable locations, especially where variations were noted. Some pits were sampled for analyses. When soils were encountered that were not covered in the preliminary legend, new soil mapping units were established. About 38,000 hectares were covered in this fashion on a scale of 1:25,000 on base maps furnished by the Cartographic Service.

An additional area of 2,500 hectares west of Shari River was mapped in considerable detail. The frequency of examinations there was on the order of about five hectares. This was made on a scale of 1:16,000 on overlays on aerial photographs.

Contact between the pedologists and the other members of the mission was maintained through discussions by making occasional joint field trips.

SOIL MAPPING LEGEND

The soil mapping unit (phase) is indicated by a composite symbol which includes the individual symbols showing the soil type, the gradient of slope and the degree of accelerated erosion. These several individual symbols form a composite symbol in the form shown below:

$$\frac{\text{Soil type}}{\text{Slope- Erosion}}$$

Where the area delineated on the map does not permit the symbol to be shown in this fractional form, the individual symbols are arranged in a horizontal or vertical sequence with soil type, slope and erosion following in order.

The soil type is designated by an allotted number. The slope factor is shown by an appropriate capital letter and the degree of erosion by a number as follows:

$$\frac{1}{B - 2}$$

A solid black line shows the boundary of each area delineated. Descriptions of the slope classes, definitions of the degrees of erosion and the composite symbols identifying the various soil types and phases are given below:

Slope

The several slope classes each with a characteristic gradient range are as follows:

A	0-3 per cent	Nearly level
B	3-8 per cent	Undulating or gently sloping
C	8-15 per cent	Moderately sloping or rolling
D	15-25 per cent	Strongly sloping or hilly
E	25-45 per cent	Steeply sloping or very hilly
F	45-and over	Very steep or mountainous

Erosion

The severity of accelerated erosion if any has occurred is shown by a number. Four degrees of erosion are recognized and these are defined as follows:

1. Little or no erosion
2. Moderate erosion
   5-50 per cent of the surface A_{11} horizon has been affected. Removal by running water or disturbed by rain splash, excessive tillage. Moderately hummocky micro-relief. Hummocks up to 10 cm. high.
3. Severe erosion
   Over 50 per cent or nearly all of the surface soil A_{11} horizon has been affected. Hummocky micro-relief. Hummocks up to 20 cm. high.
4. Very severe erosion
   All of the surface soil A_{11} horizon has been removed.

Soil Types and Phases

1/D-1	Rona loam
1/D-2	Rona loam, moderately eroded phase
1/D-3	Rona loam, severely eroded phase
1/B-1	Rona loam, gently sloping phase
1/B-3	Rona loam, gently sloping, severely eroded phase
2/D-1	Rona loam, moderately rocky phase
2/D-2	Rona loam, moderately rocky, moderately eroded phase.
2/D-3	Rona loam, moderately rocky, severely eroded phase
2/B-1	Rona loam, gently sloping phase
3/D-1	Pegno gravelly loam, rocky sloping phase
3/B-2	Pegno gravelly loam, moderately eroded rocky phase
4/B-1	Setchama clay loam
4/B-3	Setchama clay loam, severely eroded phase
7/C-1	Aoda clay loam
7/C-2	Aoda clay loam, moderately eroded phase
7/C-3	Aoda clay loam, severely eroded phase
7/B-1	Aoda clay loam, gently sloping phase
7/B-2	Aoda clay loam, moderately eroded, gently sloping phase
8/B-1	Pegno gravelly loam
8/B-3	Pegno gravelly loam, severely eroded phase
8/D-1	Pegno gravelly loam, sloping phase
8/D-2	Pegno gravelly loam, moderately eroded sloping phase
8/D-3	Pegno gravelly loam, severely eroded sloping phase
9/C-1	Libi loam
9/E-1	Libi loam, steep, rocky phase
10/B-2	Shari clay loam, moderately eroded phase
10/B-3	Shari clay loam, severely eroded phase
11/C-2	Dadwoda clay loam, moderately eroded phase
11/C-3	Dadwoda clay loam, severely eroded phase
12/B-1	Mboro clay loam
12/B-2	Mboro clay loam, moderately eroded phase

$\frac{12}{B-3}$	Mboro clay loam, severely eroded phase
$\frac{12}{C-2}$	Mboro clay loam, sloping phase
$\frac{13}{C-1}$	Kampala clay loam
$\frac{13}{C-2}$	Kampala clay loam, moderately eroded phase
$\frac{13}{C-3}$	Kampala clay loam, severely eroded phase
$\frac{14}{C-1}$	Loda clay loam
$\frac{15}{C-1}$	Dzaga clay loam
$\frac{20}{C-1}$	Gota clay loam
$\frac{20}{C-2}$	Gote clay loam, moderately eroded phase
$\frac{20}{C-3}$	Gote clay loam, severely eroded phase
$\frac{20}{B-1}$	Gote clay loam, gently sloping phase
$\frac{20}{B-3}$	Gote clay loam, severely eroded gently sloping phase
$\frac{21}{B-1}$	Djumali clay loam
$\frac{21}{B-3}$	Djumali clay loam, severely eroded phase
$\frac{21}{C-1}$	Djumali clay loam, sloping phase
$\frac{21}{C-3}$	Djumali clay loam, severely eroded, sloping phase
$\frac{25}{A-1}$	Uswalo muck
$\frac{26}{B-1}$	Loluda loam
27	Marsh
$\frac{28}{A-1}$	Djoda clay loam
$\frac{30}{B-1}$	Niagaki gravelly loam
$\frac{30}{E-2}$	Niagaki gravelly loam, steep phase
$\frac{31}{D-1}$	Luga loam
$\frac{31}{D-2}$	Luga loam, moderately eroded phase
$\frac{31}{D-3}$	Luga loam, severely eroded phase
$\frac{31}{B-1}$	Luga loam, gently sloping phase
$\frac{31}{B-3}$	Luga loam, severely eroded, gently sloping phase
$\frac{37}{C-1}$	Tshombe clay loam
$\frac{37}{C-2}$	Tshombe clay loam, moderately eroded phase
$\frac{37}{C-3}$	Tshombe clay loam, severely eroded phase
$\frac{37}{B-1}$	Tshombe clay loam, gently sloping phase
$\frac{37}{B-2}$	Tshombe clay loam, moderately eroded, gently sloping phase
$\frac{37}{B-4}$	Tshombe clay loam, very severely eroded, gently sloping phase
$\frac{40}{D-3}$	Munzi gravelly loam
$\frac{40}{B-2}$	Munzi gravelly loam, gently sloping phase

$\frac{41}{D-1}$	Golu loam
$\frac{41}{D-3}$	Golu loam, severely eroded phase
$\frac{41}{B-2}$	Golu loam, moderately eroded, gently sloping phase
$\frac{47}{C-1}$	Grobler clay loam
$\frac{47}{C-2}$	Grobler clay loam, moderately eroded phase
$\frac{47}{C-3}$	Grobler clay loam, severely eroded phase
$\frac{47}{B-1}$	Grobler clay loam, gently sloping phase
$\frac{47}{B-2}$	Grobler clay loam, moderately eroded, gently sloping phase
$\frac{51}{B-1}$	Djuda clay loam
$\frac{51}{B-3}$	Djuda clay loam, severely eroded phase
$\frac{51}{D-1}$	Djuda clay loam, sloping phase
$\frac{51}{D-3}$	Djuda clay loam, severely eroded, sloping phase
$\frac{53}{E-1}$	Nguma stony loam
$\frac{77}{C-1}$	Zeu clay loam
$\frac{77}{C-2}$	Zeu clay loam, moderately eroded phase
$\frac{77}{C-3}$	Zeu clay loam, severely eroded phase
$\frac{77}{B-1}$	Zeu clay loam, gently sloping phase
$\frac{77}{B-3}$	Zeu clay loam, severely eroded, gently sloping phase

SOIL TYPES

Twenty-six soil types with 83 phases were mapped in the area. A general description and discussion of each soil type and phase are given together with the analytical data available. Additional individual profile descriptions and analytical results are given in the appendix. The map symbol for each type or phase follows the name of the unit.

Aoda clay loam (Symbol $\frac{7}{C-1}$)

Aoda clay loam includes the Latosol soils developed on the deep, permeable, friable materials derived largely from the granitoid rock association. This soil occurs most frequently on the nearly-level or gentle to long moderately-steep slopes (up to about 18 per cent). Savanna in which Hyparrhennia and Pennisetum species are prevalent, is the normal cover where the soil has not been disturbed.

This soil type has all the characteristics of a well-developed Latosol of the region. The very dark gray or black moderately-acid, moderately granular A_{11} horizon is about fifteen centimeters thick and carries abundant roots. The dark reddish-brown subsurface (A_{12} and A_{13} horizons) has a weakly-developed coarse granular structure. It grades into the red or dark red acid B_1 horizon (2.5 YR 4/6 or 3/6 when dry) at about forty centimeters. The latter generally has a somewhat higher clay content, being a clay loam or clay, and has a weakly-developed, friable subangular structure. At about eighty to ninety centimeters, it merges into the dark red or dark reddish-brown B_2 the "dark horizon", which extends to a depth of about two meters. It has about the same texture as B_1 but has a weakly-developed, very friable subangular structure that breaks easily into weak, fine crumb. Generally, too, it carries some dark reddish-brown, moderately-firm or firm subangular or subrounded pseudo-concretions or aggregates. It merges gradually into the brighter red acid B_3 horizon (2.5 YR 4/6 or 3/6 when dry) which in turn

fades into the friable, acid, red (2.5 YR 4/6) parent material (C horizon) of a similar texture at a depth of about two and one-half meters. This red color tends to assume an orange cast when dry. Pseudo-concretions or small, firm pellets of the same color as the soil are common in the B_3 horizon. A "stone line" may be encountered in the B_3 or the C horizon at varying depths. It has been observed that the A horizon of this soil on the nearly-level or gentle slopes is not as acid as that of the soil on slopes. It is usually medium or strongly acid on slopes but is only medium or slightly acid on the gentle or nearly-level areas.

Some variations of Aoda clay loam have been mapped. The lower slopes in some cases appear to have a lower coarse sand and a higher clay content than encountered commonly. Some of the areas mapped around the edges of Shari River basin carry some detrital laterite in the "stone line".

Aoda clay loam is an important and extensive soil type in the area. Its fertility level is found to be almost equal to that of Rona loam, which together with the Luga loam, the Tshombe clay loam and the soils developed on materials derived from basic rocks make up the more fertile soils in the area. The soil is widely cultivated by the natives. It should lend itself well to production of native food crops and to the plantation crops of the area, such as coffee.

A description and analyses of one of the profile samples (Profile No. 541) of Aoda loam collected in the area is included:

Location:	About 400 meters east of road near Aoda River bridge on the Gabu-Golu Road.
Position:	Lower part of long 15 per cent slope about 500 meters long.
Vegetation:	Savanna with Hyparrhenia dominant.

A_{11}	0-20 cm.	Black clay loam. 5 YR 2/1-2/2 (dry). Moderately-developed fine to medium crumb structure. Roots abundant.
A_{12}	20-30	Dark reddish-brown clay loam 5 YR 2/2 (moist) 5 YR 3/2 (dry). Weakly-developed medium crumb structure.
A_{13}	30-45	Dark reddish-brown clay 2.5 YR 2/4-2/2 (moist) 5 YR 3/3 (dry). Weakly-developed fine subangular structure. Roots abundant.
B_1	45-85	Dark reddish-brown clay 2.5 YR 3/6 (moist) 2.5 YR 3/6 (dry). Weak to moderately-developed fine to medium subangular structure. Slightly sticky and plastic.
B_2	85-160	"Dark horizon". Dark reddish-brown clay 2.5 YR 2/4 3/4 (moist) 2.5 YR 3/4-3/2 (dry). Very weakly-developed fine to developed subangular structure. Very friable. Considerable fine to medium-sized moderately-firm aggregates.
B_3	160-225	Dark reddish-brown clay 2.5 YR 3/4 (moist) 2.5 YR 4/6 (dry). Very weakly-developed fine to medium subangular structure. Slightly sticky and plastic. Considerable dark reddish-brown, moderately-firm pseudo-concretions or aggregates. Little or no roots evident.
C	225-280	Dark red clay 2.5 YR 3/6 (moist). Very weakly-developed fine to medium subangular structure. Friable.

Analyses of Profile 541, Aoda Clay Loam
(Data by INEAC - Yangambi)

Horizon	Depth (cm)	Clay % 2 u	Silt % 2-50 u	Sand 50-2000 u	pH	Carbon %	Nitrogen %	Exchangeable bases ME/100 grs.	Exchangeable bases ME/100 grs.
A_{11}	0-20	49.4	23.2	27.4	5.3	3.84	0.391	14.8	7.4
A_{12}	20-30	42.9	16.3	40.7	4.9	1.95	0.181	3.8	- -
A_{13}	30-45	48.4	15.5	36.1	5.1	1.22	0.124	3.5	- -
B_1	45-85	49.7	22.0	28.3	4.9	0.57	0.086	3.8	- -
B_2	85-160	44.6	18.6	36.8	4.3	0.67	0.065	3.6	- -
B_3	160-225	64.6	17.7	27.3	4.8	0.32	0.037	4.2	- -

Aoda clay loam, moderately-eroded phase (Symbol $\frac{7}{C-2}$)

The moderately-eroded phase tends to have somewhat lighter-colored and thinner topsoils. The very dark gray A_{11} horizon is between eight and fifteen centimeters thick and has a weakly-developed granular or crumb structure. Where it has been mixed, the color is generally a dark reddish brown. It is somewhat more acid than the A_{11} of the uneroded soil.

This is a common and extensive soil in the area and is widely used by the natives. Analysis shows, however, that it has suffered some loss of plant nutrients with erosion. It should still do reasonably well for production of native food crops and grazing but should not be used for such crops as coffee.

Aoda clay loam, severely-eroded phase (Symbol $\frac{7}{C-3}$)

This phase of Aoda loam occurs in a number of places though the total area is not large. It has a thin dark gray topsoil, generally less than eight centimeters in thickness, and a weak granular or crumb structure. Where it has been mixed by tillage operations, it may be dusky red or dark reddish brown on the surface.

The soil has a low level of fertility and should have only limited use for production of native food crops. Its best use would be pasture.

Aoda clay loam, gently-sloping phase (Symbol $\frac{7}{B-1}$)

This is a common soil in the area. Many of the gently-sloping or nearly-level summits of the intermediate and lower surfaces in the granitic area carry this soil. It has a topsoil similar to the normal type in color, texture, structure and thickness. The difference is primarily in the B horizon. The B_1 is thinner, generally thirty or forty centimeters, and darker, being a dark red or dark reddish brown. The B_2 is very well developed both in color and depth. There is less contrast between the B_1 and B_2 horizons, and the entire solum has a darker reddish appearance than that of the normal type.

According to analysis this phase has only a slightly-acid topsoil, the pH ranging from 5.5 to 6.7. Exchange capacity and exchangeable calcium are also higher than in the normal type. This soil indicates a relatively-high level of fertility and should do well with all the native crops. It should be especially adapted to acidity-sensitive crops such as some of the legumes. Crops such as coffee may not do so well only because of the exposed position on summits that this soil occupies.

Aoda clay loam, gently-sloping, moderately-eroded phase (Symbol $\frac{7}{B-2}$)

The topsoil in this phase is a very dark gray loam from eight to fifteen centimeters thick. As in the other moderately-eroded soils, the structure is generally a weak granular or crumb. Where there has been considerable cultivation and mixing, the color may be a dusky red or a dark reddish brown.

Despite some deterioration by erosion, analyses indicate that the fertility of this soil is relatively high and that it is not so acid as the comparable phase on the slope. Its use should be similar to that of the gently-sloping phase that has not been seriously affected by erosion.

Dadwoda clay loam, moderately-eroded phase (Symbol $\frac{11}{C-2}$)

This type includes the Latosol soil developed on the deep, red, friable fine-textured materials derived in part at least from the laterite of the upper Shari River area. The soil occurs in close association with those of the Shari series, the latter generally occupying the nearly-level or gently-sloping summits. Dadwoda soils are found most commonly on the moderately-steep slopes (10-18 per cent) or on the narrow ridge-like hilltops. The vegetation is primarily savanna with the Loudetia species being by far the most common. Species of Exotheca, Elionurus and Andropogon are also common in some localities.

Dadwoda clay loam has moderately-thick reddish-black or dark reddish-brown A_1 horizon, a red B_1, a dark red or dark reddish-brown B_2 and a red friable parent material. The A_{11} which

is about ten centimeters thick is generally a dusky red or reddish-black clay loam with weakly-developed fine to coarse granular structure. This is underlain by reddish-brown A_{12} and A_{13} horizons of a similar texture but generally a weakly or moderately-developed coarse granular structure. The red or dark red B_1 comes in at about forty centimeters with a clear boundary and continues to about the 90-centimeter depth where it merges gradually into the dark red or dusky red clay (10 R 3/4) B_2 horizon. The structure of the B_1 is a weakly-developed fine to medium subangular in the moist state. This becomes more pronounced moderately-developed fine subangular when the soil is dry. Very weakly-developed soft fine to medium subangular structure is found in the B_2. Some dark reddish-brown firm aggregates or pseudo-concretions are found in this horizon more frequently than in the B_1. The B_2 horizon is underlain by a dark red (10 R 3/6) B_3 with a very weak fine to medium subangular structure. It, too, carries some dark red or dark reddish-brown moderately-firm aggregates or pseudo-concretions. It fades into the red friable, clayey parent material at about the two and one-half meter depth. A "stone line" containing considerable pebbly laterite or as DuPreez calls it detrital laterite (6) is encountered several meters below the surface.

There is little textural variation in the profile. The A horizon contains somewhat less clay--about fifty per cent-- but has a clay loam feel. Below this horizon the clay content rises to about 60 per cent and remains fairly uniform in the B and C horizons. Fine and very fine sand make up a large portion of the sand fraction in this soil.

The soil is acid throughout. The A horizon has a pH of about 5.1 while the B and C horizons are generally slightly more acid, ranging from about pH 4.5 to about 5.1. These soils are also low in exchangeable bases, being around five millieequivalents per hundred grams of soil in the A horizon. This is the lowest for the Latosols of the area.

No uneroded phase was mapped. Small areas were found where the A_{11} horizon had a darker color and was around fifteen centimeters thick. In most cases it has a hummocky micro-relief, with hummocks ranging from eight to twenty centimeters in height.

Dadwoda clay loam is a highly erodible soil of low fertility. It has but limited use for native food production and should be used primarily for grazing.

Profile No. 545, taken in East Shari River area, is included as an example of Dadwoda clay loam, moderately eroded phase.

Location: About one kilometer east of west branch of Shari River. Two kilometers west of Colon Monet.
Position: Lower third of long (500 meters) south-facing 16 per cent slope.
Vegetation: Savanna - mainly Loudetia spp.

A_{11}	0-10 cm	Reddish-black clay loam 10 R 2/1 (moist). 5 YR 3/4 (dry). Weakly-developed fine to coarse granular structure. Friable. Roots abundant.
A_{12}	10-25	Very dusky red clay loam 10 R 2/2 (moist) 2.5 YR 3/4 (dry). Moderately-developed coarse granular structure. Roots abundant.
A_{13}	25-40	Dusky red clay loam 10 R 3/2 (moist) 2.5 YR 3/6 4/6 (dry). Weakly-developed fine subangular structure. Roots numerous.
B_{11}	40-60	Dark red clay 10 R 3/6 (moist) 2.5 YR 4/8 (dry). Moderately-developed subangular structure. Firm in place. Roots common.
B_{12}	60-80	Dusky red clay 10 3/4-3/6 (moist). 10 R 2.5 YR 4/8 (dry). Very weak fine to medium subangular structure. Roots common. Few friable aggregates or pseudo-concretions.
B_2	80-185	"Dark horizon". Dusky red clay 10 R 3/4 (moist) 10 R 2.5 YR 3/6 (dry). Very friable and porous. Very weakly-developed fine to medium subangular structure. Some fine dusky red moderately-firm pseudo-concretions. Many roots in upper part. Few in lower.
B_3	185-240	Dark red clay 10 R 3/6 (moist). 10 R 2.5 YR 4/6 (dry). Weakly-developed fine subangular structure. Very friable (moist). Some fine pseudo-concretions.
C	240-290	Dark red clay 2.5 YR 10 R 3/6 (moist) 10 R 2.5 YR 4/8 (dry).
D_{1u}	290-350	Stone line. Dark red gritty clay 2.5 YR 10 R 3/6 (moist) 10 R 2.5 YR 5/8 (dry). Laterite and quartz pebbles up to one centimeter in diameter.
D_2	350-440	Dark red gritty clay 2.5 YR 3/6 (moist) 10 R 2.5 YR 4/8 (dry). Laterite and quartz pebbles.
D_3	440-510	Red micaceous clay. 2.5 YR 4/6 3/6 (moist) 10 R 5/8-6/8 (dry).

Analyses of Profile No. 545, Dadwoda Clay Loam, moderately eroded phase
(Data by INEAC - Yangambi)

Horizon	Depth (cm)	Clay % 2 u	Silt % 2-50 u	Sand % 50-2000 u	pH	Carbon %	Nitrogen %	Exchangeable bases ME/100 grs.	Exchangeable calcium ME/100 grs.
A_{11}	0-10	49.1	18.6	31.7	5.1	2.25	0.180	6.3	2.7
A_{12}	10-25	60.7	14.0	25.2	4.9	1.62	0.124	3.8	0.8
A_{13}	25-40	51.8	15.3	32.8	4.9	1.20	0.107	3.7	1.1
B_{11}	40-60	56.9	15.2	24.6	4.9	0.92	0.078	4.0	0.9
B_{12}	60-80	64.6	14.7	18.7	4.9	0.74	0.068	4.2	1.4
B_2	80-185	60.2	14.8	23.8	4.9	0.62	0.052	4.2	1.1
B_3	185-240	63.5	14.7	20.9	5.0	0.38	0.026	4.8	1.3
C	240-290	59.8	17.5	22.7	5.1	0.26	0.026	5.0	1.2
D_{1u}	290-350	56.4	20.2	23.3	5.3	0.19	0.018	5.2	
D_2	350-440	51.2	24.1	22.8	5.3	0.13	0.017	4.5	
D_3	440-510	44.0	31.3	24.8	5.2	0.12	0.013	4.2	

Dadwoda clay loam, severely-eroded phase (Symbol $\frac{11}{C-3}$)

This soil has a dark reddish-brown topsoil when moist or reddish brown or dark reddish gray when dry. The topsoil is thin, usually less than seven centimeters thick and tends to have a coarser structure. Hummocks up to twenty centimeters are common. This phase is of even lower fertility than the moderately-eroded phase and should be used only for controlled grazing.

Djoda clay loam (Symbol $\frac{28}{A-1}$)

This type includes the soils of the low alluvial terraces along some of the larger streams in the area. These soils are relatively inextensive and are found mainly along the Djoda and the Veda Rivers in the northeastern part of the area. A few small areas are likewise found along the Loluda and the Omi Rivers. These soils are generally only moderately well or imperfectly drained occurring on alluvial terraces that are but a few meters above the water level of the adjoining streams.

The topsoil consists of very dark gray or black, medium or slightly acid A_{11} horizon with a granular structure and loam texture. At about twenty centimeters this horizon passes into a dark reddish-brown A_{12} of a similar texture but with a coarser granular structure. This is underlain at forty centimeters by a red or yellowish-red B_1 horizon. This has a clay loam texture and a moderately-developed fine subangular structure. The dark reddish-brown acid B_2 horizon (the dark horizon) comes in at ninety centimeters and continues to about the 150 centimeter depth where it passes into a yellowish-red B_3. The B_2 has a clay texture, and a weak fine to medium subangular structure with some moderately-firm darker aggregates and coatings. Numerous small (5 mm in diameter), black, moderately-hard rounded pellets are found in the yellowish-red B_3 horizon. This horizon passes rather sharply into a yellowish-red C horizon of variable texture and mottled with yellowish-brown and gray.

Imperfectly-drained alluvial terrace soils were included in this type. In such cases the dark A_1 horizon passes into a light-yellowish-brown subsoil mottled with yellowish brown, reddish yellow and gray.

Djoda loam is a soil of relatively high fertility level and because of its position should have adequate soil moisture in most cases. All of the cultivated crops of the region should do well on this soil.

Profile No. 637, a profile sample of Djoda loam is described below:

Location:	1-1/2 kilometers east of Tshombe Mission on Djoda River.
Position:	Nearly-level alluvial terrace about 200 meters wide. Terrace about 6 meters above water level. Elevation 1620 meters.
Vegetation:	Heavily-grazed native pasture.

A_{11}	0-5 cm	Very dark gray loam. 7.5 YR 2/0 (dry). Coarse granular structure. Roots abundant. Soil appears to have been compacted by cattle tramping.
A_{11}	5-26	Black loam 2.5 YR 2/0 (moist) 10 YR 2/1 (dry). Well-developed medium granular structure.
A_{12}	26-40	Dark reddish-brown loam 5 YR 3/2 (moist) 5 YR 3/4-4/4 (dry). Moderately-developed subangular-granular structure. Roots abundant.
B_1	40-75	Dark red loam. 2.5 YR 3/6 4/6 (moist) 5 YR 4/6 (dry). Moderately-developed fine subangular structure (dry). Moderately friable. Some penetrations of dark reddish-brown material along cracks from above. Lower boundary gradual. Upper distinct.
B_{21}	75-90	Dark red loam 2.5 YR 3/6 (moist) 5 YR 4/4 (dry). Weakly-developed subangular structure. Friable. Roots common. Some dark reddish-brown coatings and moderately-firm aggregates.
B_{22}	90-140	"Dark horizon". Dark reddish-brown clay. 2.5 YR 3/4 (moist) 5 YR 3/4 4/4 (dry). Moderately firm in place. Some dark reddish-brown (2.5 YR 2/4) moderately-firm aggregates and coatings.
B_{31}	140-205	Yellowish-red clay loam. 5 YR 4/8 (moist) 5 YR 5/6 (dry). Very weak fine to medium subangular structure. Very friable. Numerous small black rounded moderately-hard concretions.
B_{32g}	205-230	Yellowish-red loam (5 YR 4/8 moist) 5 YR 6/6 6/8 (dry). Mottled faintly with brownish-yellow 10 YR 6/6. Very friable.
C_{1g}	230-340	Yellowish-red clay 5 YR 5/8 (moist) mottled with yellowish-brown 2.5 YR 5/8 and gray.
C_{2g}	340-360	Mottled brownish-yellow and gray clay loam.
C_{3g}	360-400	Yellowish-brown clay loam mottled with brownish yellow gray and some black specks.

Analyses of Profile No. 637, Djoda Loam
(Data by INEAC - Yangambi)

Horizon	Depth (cm)	Clay % 2 u	Silt % 2-50 u	Sand 50-2000 u	pH	Carbon %	Nitrogen %	Exchangeable bases ME/100 grs	Exchangeable calcium ME/100 grs.	T value pH6.7	T value pH5.1
A_{11}	0-5	43.5	24.4	32.1	6.0	3.09	0.367	22.7	13.6	18.6	17.9
A_{11}	5-26	38.1	28.4	33.5	5.8	3.08	0.320	22.2	12.4	18.7	14.2
A_{12}	26-40	52.9	21.7	25.4	5.7	1.67	0.158	9.3	2.8	9.2	7.0
B_1	40-75	60.2	14.9	24.9	5.3	0.69	0.088	8.1	1.2	7.9	6.9
B_{21}	75-90	65.5	12.7	21.8	4.8	0.79	0.053	7.3	1.6	9.7	8.1
B_{22}	90-140	68.2	11.2	20.6	5.2	0.79	0.055	7.2	- -	10.6	9.1
B_{31}	140-205	57.3	19.3	23.4	5.4	0.34	0.040	7.3	1.3	7.1	6.0
B_{32g}	205-230	58.2	19.4	22.4	5.0	0.32	0.038	5.3	1.1	8.3	6.6
C_{1g}	230-340	69.4	18.7	11.9	4.8	0.30	0.022	5.6	1.3	10.6	9.4
C_{2g}	340-360	64.9	19.7	15.4	4.6	0.30	0.022	4.8	0.3	10.5	9.2
C_{3g}	360-400					0.25	0.013			9.1	7.8

Djuda clay loam (Symbol $\frac{51}{B-1}$)

This is a Humic Red Latosol soil developed on the moderately-deep materials derived largely from weathered dark basic rocks. It is found on the gently-sloping summits or on the moderately-steep or steep upper slopes. A large per cent of this soil is cultivated; but where it has not been disturbed recently, the vegetation is primarily a rank savanna with Hyparrhenia sp. prevailing.

The slightly acid, very dark gray or black clay loam surface soil is rather thick, sometimes up to twenty-five centimeters, and has a well developed granular structure. Where it has been cultivated appreciably, it is usually very dark gray in color and has a loose fine crumb structure instead of being granular. This surface grades through a dark reddish-brown clay loam granular subsurface into the slightly-acid red or reddish-brown or dark red clay loam subsoil (B horizon) at about forty centimeters. The latter has fairly well developed fine to medium subangular structure of moderately-friable consistence when moist and moderately plastic when wet. This subsoil generally terminates at a depth of about one meter in a "stone line"

carrying considerable partially-weathered basic rock fragments or in the weathered zone of the underlying parent basic rock. Adjoining granitoid rocks frequently have contributed appreciably to the parent material of this soil. In such cases considerable quartz sand and grit may be present in the solum. Further, since this soil occurs in areas where the dark basic rocks appear on the surface, the soil is often somewhat rocky.

Djuda clay loam is a common though relatively inextensive soil occurring mainly as small areas. It is the most fertile soil in the area and is well adapted to all cultivated crops in the area.

Most of this soil is under cultivation so has suffered considerable deterioration through erosion and breakdown of granular structure. It appears to be more erodible than the moderately-deep soils developed on materials derived from granitoid rocks. The severaly-eroded phases are not adapted to production of plantation crops but could be used for native food crops and for grazing.

Profile No. 603 is presented as an example of Djuda clay loam:

Location:	2 kilometers west of Luga Mission.
Position:	Gently-sloping (6 per cent) summit of dark basic rock dike.
Vegetation:	Cultivated with heavy stand of postcultural grasses.

A_p	0-14 cm.	Very dark gray clay loam. 5 YR 2/2 (dry). Loose fine crumb structure.
A_{12}	14-29	Black clay loam. 5 YR 3/2 (dry). Moderately-developed medium granular. There are some indications of weak medium prismatic forms.
A_{13}	29-42	Dark reddish-brown clay loam. 2.5 YR 3/2 3/4 (dry). Moderately-developed granular structure.
B_{11}	42-53	Dark red clay. 2.5 YR 3/7 (dry). Fine well developed subangular structure.
B_{12}	53-80	Dark red clay. 2.5 YR 3/8 (dry). Moderately-developed subangular structure. Firm in place when dry.
C	80-95/	Weathered dark basic rock fragments. Fragments have a reddish-yellow weathered shell. Red clay matrix between fragments.

Analyses of Profile No. 603, Djuda Clay Loam
(Data by INEAC - Yangambi)

Horizon	Depth (cm)	Clay % 2 u	Silt % 2-50 u	Sand % 50-2000 u	pH	Carbon %	Nitrogen %	Exchangeable bases ME/100 grs.	Exchangeable calcium ME/100 grs.	T value pH 6.7
Ap	0-14	41.4	22.3	36.3	6.5	4.55	0.468	25.4	15.6	32.4
A_{12}	14-29	38.7	25.3	36.0	6.4	3.57	0.387	24.5	14.0	25.1
A_{13}	29-42	45.8	21.7	32.5	6.3	1.82	0.200	11.4	5.0	12.9
B_{11}	42-53	49.6	24.4	26.0	6.2	0.95	0.124	8.9	2.3	9.2
B_{12}	53-80	56.5	19.2	24.3	5.9	0.71	0.088	7.0	2.0	7.8
C	80-95/	54.2	14.4	29.4	5.8	0.79	0.098	7.0	1.0	- -

Djuda clay loam, severely-eroded phase(Symbol $\frac{51}{B-3}$)

This phase has a dark reddish-brown or reddish-brown or dark reddish-gray topsoil that usually has a weak granular or loose weak crumb structure.

Djuda clay loam, sloping phase (Symbol $\frac{51}{D-1}$)

Soils of this phase occur on nearly-level or gently-sloping summits, and in this position there is generally less admixture of materials derived from granitic or metamorphic rocks. Quartz sand and grit is less common in these soils. This phase includes the moderately-eroded soils as well.

Djuda clay loam, severely-eroded, sloping phase (Symbol $\frac{51}{D-3}$)

A reddish-brown or dark reddish-brown color of topsoil is a common characteristic of these soils. The structure, too, indicates deterioration and is generally a weak granular or weak fine crumb.

Djumali clay loam (Symbol $\frac{21}{B-1}$)

Djumali clay loam includes the Humic Red Latosol soils with dusky red solum developed on materials derived in part at least from dark basic rocks. Soils of this type usually occupy the more extensive, nearly-level or gently-sloping areas having these basic rocks in the vicinity. These materials usually include mixtures from other adjoining rock associations, of which granite is most common. Savanna with Hyparrhenia sp. prevailing is the common vegetation in areas not disturbed recently.

This type has a relatively-thick, very dark surface soil and a dusky-red subsoil over dark red parent materials. The A_{11} horizon, about fifteen centimeters thick, is a black or very dusky-red clay loam with a moderately-developed fine granular structure. The subsurface which extends to about forty centimeters is a dusky-red or dark reddish-brown clay loam with a somewhat coarser granular structure. Below this depth and extending to about 100 centimeters, the B_1 shows up as a somewhat lighter dusky-red or dark red horizon with a weakly-developed fine to medium subangular structure. The B_2 horizon is somewhat darker dusky red than the B_1 and extends to about the 2 meter depth. This has a clay texture and a soft friable, very weakly-developed fine to medium subangular structure. Some moderately-firm dark aggregates are found in this horizon. This is underlain by red clayey parent material which extends to varying depths. In some cases the soil profile rests on partially-weathered basic rock.

The soil appears to have a relatively-high level of fertility. Exchangeable calcium is around ten ME. per 100 grs. in the medium or slightly-acid surface soil. The subsoil, however, is generally acid and has about the same level of exchangeable bases as the other deep soils. All of the cultivated crops adapted to this region should do well on this soil. The most extensive areas of this soil are found in the vicinity of north colons Vencken and Decock.

Analyses and description of Profile No. 516 are included as an example of Djumali clay loam:

Location:	2 kilometers northwest of Djumali.
Position:	Nearly-level hilltop about 150 meters wide.
Vegetation:	Hyparrhennia savanna with Erythrina and Acacia spp. and some brush and forbs.

A_{11}	0-12 cm.	Black clay loam 5 YR 2/1 (moist) 2/5 YR 2/2 (dry). Moderately-developed granular structure.
A_{12}	12-30	Very dusky-red clay loam. 2.5 YR 2/2 (moist) 5 YR 3/3 (dry). Weakly-developed fine subangular structure. Friable.
A_{13}	30-50	Very dusky red clay 10 R 2/2 (moist) 2.5 YR 3/4 (dry). Weakly-developed fine subangular structure. Friable.
B_1	50-65	Dusky-red clay 10 R 3/2 3/3 (moist) 2.5 YR 3/6 (dry). Weakly-developed fine to medium subangular. Friable.
B_{21}	65-100	Dusky-red clay 10 R 3/3 (moist) 2.5 YR 3/6 (dry). Weakly-developed fine to medium subangular structure.
B_{22}	100-145	Dusky-red clay 10 R 3/3 (moist) 2.5 YR 3/6-3/4. Very friable.
B_3	145-195	Dusky-red clay 10 R 3/4 (moist) 2.5 YR 3/6 (dry). Very weakly-developed fine to medium subangular structure. Some moderately-firm aggregates or pseudo-concretions.
C_1	195-300	Dark red clay 10 R 3/6 (moist) 2.5 YR 4/8 (dry). Weakly-developed fine to medium subangular structure. Friable. Moderately firm in place.
C_2	300-475	Dark red friable clay 10 R 3/6 (moist) 2.5 YR 4/8 (dry).

Fragments of dark fine-grained basic rocks were found in the material.

Analysis of Profile No. 516 - Djumali Clay Loam
(Data by INEAC - Yangambi)

Horizon	Depth (cm)	Clay % 2 u	Silt % 2-50 u	Sand 50-2000 u	pH	Carbon %	Nitrogen %	Exchangeable bases ME/100 grs.	Exchangeable calcium ME/100 grs.
A_{11}	0-12	52.0	14.2	33.8	5.9	3.87	0.354	18.4	9.9
A_{12}	12-30	52.5	12.7	34.8	5.1	1.95	0.170	3.9	- -
A_{13}	30-50	62.0	14.0	26.0	5.0	1.36	0.121	3.8	- -
B_1	50-65	46.3	16.7	37.0	4.9	1.03	0.107	4.2	- -
B_{21}	65-100	63.0	11.4	28.6	4.9	0.72	0.068	4.0	- -
B_{22}	100-145	62.0	12.3	25.7	4.9	0.56	0.041	4.3	- -
B_3	145-195	58.0	11.1	30.9	4.9	0.50	0.047	4.1	- -
C_1	195-300	60.4	8.8	31.3	5.1	0.27	0.030	5.0	- -
C_2	300-475	65.5	11.3	23.2	5.0	0.14	0.021	5.0	- -

Djumali clay loam, severely-eroded phase (Symbol $\frac{21}{B-3}$)

This phase which occurs mainly in the Vencken-Decock area is found on nearly-level or gently-sloping tracts and is recognized by its moderately-shallow (less than 8 centimeters), dark reddish-brown or reddish-brown topsoil. Generally, too, the topsoil of this phase has only a weakly-developed fine granular structure. Pasture and native food crop production should be the main use for this soil. Plantation crops such as coffee are not recommended.

Djumali clay loam, sloping phase (Symbol $\frac{21}{C-1}$)

Djumali clay loam was found to occur on moderately-steep slopes, slopes ranging up to 15 per cent in gradient. It was mapped as a sloping phase in such cases.

Djumali clay loam, severely-eroded, sloping phase (Symbol $\frac{21}{C-3}$)

Some severely-eroded Djumali clay loam similar to $\frac{21}{B-3}$ was found on moderately-steep slopes. This was designated as a severely-eroded sloping phase. Its use should be similar to that of Djumali clay loam, severely-eroded phase.

Dzaga Loam (Symbol $\frac{15}{C-1}$)

Latosol soils under forest in the area differ from those under savanna cover principally in the characteristics of the A horizon. Instead of the black, very dark gray or dark reddish-brown surface found in the latter case, the color of this horizon under forest is usually a reddish brown or a lighter shade of dark reddish brown. Often, too, the lower part of the A horizon the A_{12} is somewhat darker than the A_{11} subhorizon above. It is developed on materials similar to that of the closely-associated savanna soils which include the types, Kampala clay loam, the Grohler clay loam, the Loda clay loam and the Aoda clay loam.

This inextensive soil type occurs on the gallery forest-covered slopes along the drainageways in the western part of the area. It is characterized by a thin (usually less than 5 centimeters) layer of partially-decomposed leaves and litter. There may be a centimeter or two of crumb structure mull over the reddish-brown or dark reddish-brown A_{11} horizon which extends to about the 20-centimeter depth. The A_{12} horizon is a somewhat darker reddish-brown which grades into the red or dark red B_1 horizon at about 40 centimeters. Both A_{11} and A_{12} horizons tend to have a soft friable weakly-developed granular or crumb structure. Soft friable, weakly-developed subangular structure is common to the B_1 horizon. The latter horizon merges into a dark reddish-brown B_2, "the dark horizon", at about ninety centimeters, and this in turn passes into the red or dark red B_3 horizon at about the 2-meter depth. As in the association savanna soils, the structure of the B_2 and B_3 horizons is a weakly-developed, friable fine to medium subangular structure. Moderately-firm aggregates or Pseudo-concretions found in the savanna soils are also present in the B horizons of this type.

It appears that the fertility level of these soils is about the same of that of the associated Latosols under savanna. The values for pH and exchangeable bases are similar. The organic matter content is a slightly lower; the highest carbon content obtained was 2.85

per cent while the highest for savanna soils was slightly over 4 per cent. Dzaga clay loam has use potentialities similar to that of the associated savanna soils.

A profile sample of Dzaga clay loam (Profile No. 681) collected is western Shari River area has been described previously under the general discussion of Humic Red Latosol.

Golu loam (Symbol $\frac{41}{D-1}$)

Golu loam includes the well-drained to somewhat excessively-drained Latosol soils developed on the moderately-shallow to moderately-deep materials derived largely from laterite in the Shari River area.

The A_{11} horizon is usually a very dark gray to dark reddish-brown granular loam about ten centimeters thick. This grades into a somewhat lighter-colored dark reddish-brown weakly-granular subsurface which in turn is underlain by a red or dark red friable subsoil. The latter has a clay loam texture and a weakly-developed subangular structure. A "stone line" with considerable detrital laterite gravel and usually some quartz fragments and pebbles is encountered in the subsoil, the B horizon.

Golu loam though inextensive in total area is closely associated with the deep soils of the Dadwoda, Shari Mboro and Kampala and the shallow soils of the Munzi series. It is often found as small areas or belts on the ridge tops or narrow summits and also on the upper steep or moderately-steep slopes where these soils occur. It is particularly common on the breaks around the headwaters of many of the drainageways in this area.

All of the phases of Golu loam are of low fertility and in addition occupy the drier sites in the area. This soil should be used for grazing only.

A description of one of the sites examined in the Munzi area is included:

Location: Northwest of Munzi mountain.
Position: 12 per cent slope.
Vegetation: Brush, grass Imperata spp.

A_{11}	0-10 cm.	Very dark gray loam 5 YR 3/1 (moist). Coarse granular structure.
A_{12}	10-35	Dark reddish-brown loam. 2.5 YR 2/4 (moist). Weak granular structure.
B	35-110	Dark red clay 2.5 YR 3/6 (dry).
B_u	110-120	"Stone line". Hard detrital laterite gravel. With some quartz fragments.

Golu loam, severely-eroded phase (Symbol $\frac{41}{D-3}$)

A lighter-colored surface characterizes the severely-eroded phase of Golu loam. The surface color is a dark gray or dark reddish brown.

Golu loam, moderately-eroded-sloping phase (Symbol $\frac{41}{B-2}$)

This phase of Golu loam occurs on the nearly-level or gently-sloping summits. Too, the "stone line" occurs at somewhat greater depth, generally in the lower subsoil. The very dark gray surface soil is less than ten centimeters thick where it has not been disturbed recently. It is dark reddish brown in the disturbed areas.

Gote clay loam (Symbol $\frac{20}{C-1}$)

Gote clay loam includes the Latosol soils developed on the deep medium to fine-textured materials derived in part at least from the dark basic rocks outcropping in the area. They occur on moderately-steep slopes although some of these soils are also found on the gently-sloping summits. Savanna in which Hyparrhenia spp. constitutes the major grass is the common cover in the undisturbed areas.

Gote soils have a thick, very dark gray to black granular topsoil, a reddish upper subsoil and a dark reddish-brown lower subsoil over red parent material. In comparison to soils of Djumali series, the red color of these soils has an orange or brighter red tinge comparable

to that of the Aoda series. Those of the Djumali series have a dusky or a deeper red color, similar to that of the Mboro soils.

The slightly acid A_{11} horizon which is about fifteen centimeters thick is a clay loam with a very dark gray or dark reddish-brown color and a granular structure. Lower subsurface is likewise a granular clay loam with somewhat coarser granular structure. This horizon grades into the red acid, clay loam or clay B_1 horizon at about forty centimeters which in turn is underlain by the dark reddish-brown B_2 horizon at about ninety centimeters. The latter two horizons have a weakly-developed fine subangular structure, the B_2 horizon, however, is more easily friable. The red clay or clay loam B_3 fades into the red friable parent material at about the 2-meter depth.

Materials derived from adjoining rock associations may contribute considerably to these soils. Dikes of basic rocks are often flanked by exposures of granitoid rocks so that the resultant parent material on the slopes often has appreciable contributions from both.

Gote clay loam though limited in extent is one of the more fertile soils in the area. It is well adapted to all cultivated crops adapted to the area.

A description of one of the profile samples and analyses of Gote clay loam follows:

Profile No. 622, Gote clay loam, moderately-eroded phase:

Location:	Northwest of Luga 3-1/2 kilometers.
Position:	East-facing slope 14 per cent. Cap between dark basic rock dikes. Granite outcrop up slope to the west.
Cover:	Old cultivated field--now in postcultural grasses.

A_p	0-10 cm.	Dark reddish-brown clay loam 5 YR 2/2 (moist) 5 YR 3/2 (dry). Moderately-developed fine crumb. Loose. Heavy concentration of roots.
A_{12}	10-40	Dark reddish-brown clay loam 5 YR 3/4 (dry). Good granular structure when dry. Moderately-developed fine nuciform when moist.
B_1	40-80	Red clay 2.5 YR 4/6 (dry). Weak developed fine nuciform structure (moist). Friable.
B_2	80-140	Dark red clay 2.5 YR 3/6-4/6 (dry). Very weak fine to medium subangular structure mashing easily to fine crumb when moist.
B_3	140-200	Red clay 2.5 YR 4/8 (dry). Very weak fine nuciform mashing easily to weak medium crumb.
C_1	200-235	Red clay (2.5 YR 5/8) (dry). Weak fine nuciform structure. Small fragments of basic rock present. Some quartz sand present, coarser than above.
C_2	235-260	Weathered basic rock fragments with red clay matrix.

This soil appears to have developed on materials derived from granite and basic rock.

Analyses of Profile No. 622, Gote Clay Loam
(Data by INEAC - Yangambi)

Horizon	Depth (cm)	pH	Carbon %	Nitrogen %	Exchangeable bases ME/100 grs.	Exchangeable calcium ME/100 grs.
A_p	0-10	5.9	3.08	0.330	20.5	11.8
A_{12}	10-40	4.8	1.83	0.146	5.2	1.4
B_1	40-80	5.0	0.67	0.079	4.8	1.2
B_2	80-140	4.8	0.67	0.052	4.5	0.9
B_3	140-200	4.8	0.33	0.031	4.6	0.9
C_1	200-235	5.0	0.30	0.036	4.6	1.0
C_2	235-260	5.1	0.18	0.020	5.5	1.0

Gote clay loam, moderately-eroded phase (Symbol $\frac{20}{C-2}$)

The moderately-eroded phase is the most prevalent soil of this type. Usually the surface has a dark reddish-brown instead of very dark gray color. This still is a productive soil and could be used for all of the cultivated crops adapted to the area.

Gote clay loam, severely-eroded phase (Symbol $\frac{20}{C-3}$)

Serious erosion and deterioration of this type is indicated by the breakdown of granular structure and the brighter red color of the surface. The severely-eroded phase is characterized by a reddish-brown surface soil with a weak granular or crumb structure. Grazing and limited production of native food crops is recommended.

Gote clay loam, gently-sloping phase (Symbol $\frac{20}{B-1}$)

This phase of Gote clay loam occurs on some of the nearly-level or gently-sloping summits in the area of dark basic rock outcrops. It is similar to the normal type of this soil in most profile chracteristics except that the latter occurs on moderately-steep slopes.

Gote clay loam, severely-eroded, gently-sloping phase (Symbol $\frac{20}{B-3}$)

Severe erosion in this soil is reflected in the reddish-brown color and weakly-developed crumb or granular structure of the surface soil. This phase includes the severely-eroded soils on the nearly-level or gently-sloping areas. Use of this soil should be similar to the severely eroded phase described previously.

Grobler clay loam (Symbol $\frac{47}{C-1}$)

A Latosol soil with a brownish cast has been recognized in the northwestern part of the Shari River area. This soil has developed on materials derived largely from laterite but unlike the other dark red or dusky red soils developed on these materials the red color has a brownish cast. The type has been mapped as Grobler clay loam. It occurs most frequently on moderately steep slopes of about 10-15 per cent and supports mixed savanna. Loudetia species however appear to be the most prevalent of the grasses.

The soil has an acid black or very dark gray granular clay loam A_{11} horizon about 15 cm thick. Dark reddish brown weakly granular subsurface merges into dark red or red B_1 horizon at about 40 centimeters. The latter has clay texture and a weakly developed soft friable subangular structure. It has a well developed B_2 horizon which shows up definitely by its comparatively darker reddish brown color. As in other well developed Humic Red Latosols moderately firm aggregates or Pseudo concretions are common in this horizon. The red or dark red B_3 horizon with a clay texture and a weakly developed subangular structure fades into the red friable clay parent material below two meters.

Grobler clay loam appears to be only moderately fertile. It provides good grazing and could be used to a limited extent for native food crops. It should not be used for plantation crops. Analyses show it to be acid throughout the profile and likewise is low in exchangeable bases.

A profile sample of Grobler clay loam (Profile No. 668) was collected near the northwest corner of the area. A description of this profile and the analyses are given below:

Location: Near north boundary of survey area. 50 meters east of Cornelius ranch.
Position: Middle of 12 per cent slopes about 200 meters long. Elevation 1650 m.
Vegetation: Loudetia savanna. Some Erythrina trees. No soil hummocks, around grass clumps.

A_{11}	0-18 cm.	Black clay loam 5 YR 2/1 (moist) 5 YR 2/1 2/2 (dry). Moderately developed fine crumb structure. Roots abundant.
A_{12}	18-29	Very dusky red clay loam. 2.5 YR 2/2 (moist) 5 YR 3/2 2/2 (dry). Weakly developed coarse granular structure. Roots abundant.
A_{13}	29-44	Dark reddish brown clay loam 2.5 YR 3/4 2/2 (moist). 5 YR 3/4 (dry). Weakly developed coarse granular. Roots common.

B_1	44-80	Dark red clay 2.5 YR 3/6 (moist). 2.5 YR 3/6 5 YR 4/6 (dry). Friable, weakly developed fine to medium subangular structure.
B_{21}	80-100	Dark reddish brown clay 2.5 YR 3/4 (moist) 2.5 YR 5 YR 3/4 (dry). Soft friable subangular structure. This is the upper transition of the "dark horizon".
B_{22}	100-174	"Dark horizon". Dusky red clay 2.5 YR 3/2 (moist) 2.5 YR 3/2 5 YR 3/3 (dry). Fine soft friable weakly developed subangular structure, breaking up easily into weak fine crumb. Some firm dark reddish brown aggregates or pseudo concretions. Roots more common than in B21 or B_1.
B_{23}	174-215	Dark reddish brown clay 2.5 YR 3/4 (moist) 2.5 YR 3/6 4/6 (dry). Very friable. Soft fine subangular structure. Roots present lower "dark horizon" transition.
B_3	215-240	Red clay 2.5 YR 4/6 3/6 (moist) 2.5 YR 4/6 (dry). Weakly developed fine to medium subangular structure.
D_u	240-275	"Stone line". Much detrital laterite and angular quartz grit. Red clayey matrix.

Analyses of Profile No. 668 - Grobler Clay Loam
(Data by INEAC - Yangambi)

Horizon	Depth (cm)	Clay % 2 u	Silt % 2-50 u	Sand % 50-2000 u	pH	Carbon %	Nitrogen %	Exchangeable bases ME/100 grs.	Exchangeable calcium ME/100 grs.	T values pH6.7	T values pH 5.1
A_{11}	0-18	66.3	7.9	25.8	5.1	2.84	0.242	9.2	4.4	16.0	11.7
A_{12}	18-29	66.4	7.1	26.5	5.1	2.40	0.165	3.0	- -	12.5	9.7
A_{13}	29-44	67.6	6.6	25.8	4.8	1.75	0.114	3.2	1.0	8.0	7.0
B_1	44-80	73.0	6.6	20.4	4.9	0.89	0.074	3.8	1.0	6.3	5.0
B21	80-100	74.5	5.4	20.1	5.0	0.91	0.059	4.0	1.0	8.0	6.2
B22	100-174	74.5	5.3	21.2	5.0	1.05	0.050	3.4	1.0	9.0	6.9
B_{23}	174-215	68.8	5.7	25.5	5.2	0.71	0.043	3.9	0.7	6.3	5.0
B_3	215-240	- -	- -	- -	5.2	0.64	0.045	4.3	1.2	5.4	4.1
D_u	240-275	55.8	8.7	35.5	5.5	0.46	0.025	4.3	1.2	3.8	2.7

Grobler clay loam, moderately eroded phase (Symbol $\frac{47}{C-2}$)

Moderately eroded phase of Grobler clay loam is characterized by having a somewhat thinner or lighter colored A_{11} horizon in comparison to the normal type. This horizon in the moderately eroded phase is either dark reddish brown in color or if it is a very dark gray its thickness is about 12 centimeters or less. While its fertility is somewhat lower than that of the normal phase the use is about the same.

Grobler clay loam, severely eroded phase (Symbol $\frac{47}{C-3}$)

In this phase of Grobler clay loam the very dark gray A_{11} horizon is generally thin being less than 8 centimeters. Where it has been disturbed and this horizon has been mixed the color is a reddish brown or a lighter shade of dark reddish brown. Its use should be restricted to grazing.

Grobler clay loam, gently sloping phase (Symbol $\frac{47}{B-1}$)

A soil similar to the soil type occupies the nearly level or gently sloping hilltops. Such areas as a gently sloping phase. The use of this phase would be similar to the normal type.

Grobler clay loam, moderately eroded gently sloping phase (Symbol $\frac{47}{B-2}$)

As in the moderately eroded phase this soil in the nearly level or gentle slopes is characterized by a shallower normal very dark gray A_{11} horizon or where it has been disturbed the surface is a dark reddish brown. Its use is the same as that of the moderately eroded phase on the slopes.

Kampala clay loam (Symbol $\frac{13}{C-1}$)

A soil with a dark red or dusky red solum developed on clayey materials derived largely from laterite but with appreciable medium and coarse quartz sand has been identified as Kampala clay loam. It is closely associated with the Mboro clay loam soils in the west Shari River area, the latter soil having developed on similar materials but tend to have a somewhat darker red solum. Too the Mboro soils occur more frequently on the nearly level or gentle slopes whereas those of the Kampala series are more commonly found on the long, moderately steep slopes. Loudetia savanna is the most prevalent type of vegetation.

This type to a depth of about 12 cm is an acid, black or very dusky red clay loam with a weakly developed coarse granular structure. A dark reddish brown acid clay subsurface A_{12} and A_{13} extends to about the 40 centimeters depth where it changes into the red or dark red, clay B_1 with a clear boundary. The latter has a weakly developed fine to medium subangular structure. The "dark horizon", the B_2, starts in at about 80 cm and extends to about the two meter depth. This too has a clay texture, a soft friable very weakly developed subangular structure and a dusky red or dark reddish brown color. Consistence when moist is very friable, the units breaking up easily to a weak fine crumb. Some moderately firm to firm aggregates or pseudo concretions are found in this horizon. It merges gradually into the dark red B_3 which in turn fades indistinctly into the red friable clayey parent material at about two and one half meters. One of the distinctive features about the color of this solum is that in the moist state the red and dark red color fall on the 10 R Munsell color chart. Colors of the Aoda and Grobler soils are on the 2.5 YR or 5 YR charts. These soils are distinguished from those of the Dadwoda in that the latter have considerably less medium to coarse sand. More than half of the sand fraction of the Kampala clay loam falls into the medium to coarse category.

Kampala clay loam is an acid soil of low fertility and is easily eroded. Use of this soil for plantation crops should be avoided and even use for native food crops on any appreciable scale should be discouraged. Grazing appears to be the most intensive use to be permitted on this soil.

A profile sample of Kampala clay loam (Profile No. 679) from west Shari River area has been analyzed. The results of analyses and a profile description are included.

Location:	North central portion of west Shari detail survey block.
Position:	Lower third, west facing, 15 per cent slope. About 50 m. to marsh.
Cover:	Pteris fern, Hyparhennia spp. grass, Erythrina. No hummocks on surface.

A_{11}	0-14 cm	Very dark loam 5 YR 2/1 (moist) 5 YR 3/1 (dry). Weak coarse granular. Heavy concentration of roots.
A_{12}	14-27	Dark reddish-brown loam 5 YR 3/2 (moist) 5 YR 3/3 (dry). Weakly-developed coarse granular structure. Numerous fine roots.
A_{13}	27-43	Dark reddish-brown loam 2.5 YR 3/3 (moist) 5 YR 3/4-4/6 (dry). Weakly-developed medium granular structure. Very friable.
B_1	43-70	Red clay with yellowish tinge 2.5 YR 3/6 (moist) 2.5 YR 4/6-3/6 (dry). Weakly-developed fine subangular structure. Upper boundary gradual, lower diffuse.
B_{21}	70-118	"Dark horizon". Red clay 10 R 3/6-4/6 (moist) 2.5 YR 4/6-3/6 (dry). Somewhat lighter colored than horizon below when moist. Weak fine to medium subangular structure. Some fine, moderately-firm aggregates. Quartz of sand size common.
B_{22}	118-177	"Dark horizon". Dark red clay 10 R 3/6 (moist) 2.5 YR 4/6-3/6 (dry). Very weak soft subangular structure mashing easily to weak fine crush. Roots common. Some quartz present. Some moderately-firm aggregates.
B_{23}	177-210	Red clay 10 R 4/6-3/6 (moist) 2.5 YR 4/6 (dry). Weakly-developed fine to medium subangular structure. Friable. Quartz common. Some moderately-firm aggregates. Boundaries very diffuse. Some roots.
B_3	210-250	Red clay 10 R 3/6 (moist) 2.5 YR 4/8 (dry). Very weak fine to medium subangular structure. Friable. Quartz present.
C	250-350	Red clay 10 R 4/6-3/6 (moist) 2.5 YR 4/8-5/8 (dry). Quartz common.
D_u	350-400	"Stone line". Much detrital laterite. Some quartz grit. Red clayey matrix.
D	400-450	Light red material 10 R 5/4-5/6 (moist) 2.5 YR 6/8-5/8 (dry). Some detrital laterite. Much quartz grit.

Analyses of Profile No. 679, Kampala Clay Loam
(Data by INEAC - Yangambi)

Horizon	Depth (cm)	Clay % 2 u	Silt % 2-50 u	Sand % 50-2000u	pH	Carbon %	Nitrogen %	Exchangeable bases ME/100 grs	Exchangeable calcium ME/100 grs	T values pH 6.7	T values pH 5.1
A_{11}	0-14	58.0	10.1	31.9	5.4	3.08	0.252	8.4	4.2	16.3	9.2
A_{12}	14-27	60.8	8.7	30.5	4.8	3.00	0.153	3.7	0.9	14.6	8.9
A_{13}	27-43	62.3	8.1	29.6	5.0	1.69	0.110	3.4	0.7	7.9	6.6
B_1	43-70	66.7	7.0	26.3	5.0	1.00	0.070	4.0	0.9	7.0	5.7
B_{21}	70-118	64.7	7.4	27.9	5.0	0.70	0.047	4.1	1.0	6.9	5.8
B_{22}	118-177	65.3	7.5	27.2	5.0	0.57	0.028	4.0	1.0	6.2	5.2
B_{23}	177-210	63.5	9.0	27.5	5.0	0.46	0.028	4.2	0.8	5.4	4.1
B_3	210-250	62.5	10.6	27.9	5.0	0.25	0.021	4.4	0.6	4.6	3.6
C	250-350	62.7	10.9	26.4	5.1	0.20	0.019	4.6	0.6	5.5	4.2
Du	350-400	42.1	16.0	41.9	5.2	0.11	0.026	4.4	0.7	5.2	3.5
D	400-450	39.3	23.8	36.9	5.1	0.11	0.013	3.8	0.6	4.7	- -

Kampala clay loam, moderately eroded phase (Symbol $\frac{13}{C-2}$)

This is the most prevalent phase of Kampala soils in the area. It is characterized by a very dark gray or dark reddish brown moderately thick (7 to 12 cm) A_{11} horizon and a moderately hummocky surface. These hummocks which are a very common feature of this soil are up to 12 centimeters high. Use of this phase is similar to the normal type.

Kampala clay loam, severely eroded phase (Symbol $\frac{13}{C-3}$)

Severe erosion as indicated by the changes in color and thickness of A_{11} horizon and the extremely hummocky surface has occurred over appreciable areas of this soil. The surface soil A_{11} if it has a very dark gray surface is comparatively thin, being less than 7 cm thick. Often too the surface may have a reddish brown or a lighter shade of dark reddish brown color. The hummocks are up to 20 centimeters high. Controlled grazing is the only use recommended.

Libi loam (Symbol $\frac{9}{C-1}$)

Many of the rocky crests and upper slopes in the general Mt. Rona area carry a mantle from less than a meter to about two and one half meters thick of coarse sandy or gritty materials derived largely from the local crystalline rocks. The soils developed on these materials have a dark surface, a lighter colored coarse textured upper subsoil and a somewhat reddish colored clayey subsoil. Such soils, identified as Libi loam have been classed as being Podsolic.

The surface horizon to a depth of about 15 cm. or more is a very dark gray or black granular loam. This changes through a dark gray or dark grayish brown loam to merge at about 40 centimeters into the yellowish brown or yellowish red coarse textured gritty loamy sand the A_2 horizon which in turn extends to about 75 centimeters. The latter horizon has a poorly developed very thick platy structure, the uneven or wavy structure planes are roughly parallel to the soil slope. Fragments of vein quartz often appear in this and sometimes in the horizon below as weakly formed diffuse "stone line". The A_3 is likewise coarse textured but is usually darker colored being a brown, yellowish red or a reddish brown. The B horizon extends from about the one meter depth to the weathered rock material which comes in anywhere between the one and one half and the two and one half meter depths. This horizon is usually a gritty micaceous loam or clay loam with a very weakly developed subangular structure. The color which is a darker, yellowish red, red or reddish brown, is somewhat more red than that of the A_2 and A_3 horizons above or of the weathered rock material below.

In comparison to the soil materials of the Humic Red Latosols, the materials of Libi loam are not as highly weathered. The proportion of weatherable minerals is appreciably higher and as a consequence the fertility level of this soil is likewise higher. It is a drouthy soil because of its position and coarse textured upper solum.

Native food crops can be produced during the rainy season. Cypress plantations appear to do well on these soils and they should also produce good grasses in seasons of abundant moisture.

Boulders and outcroppings of rocks are a common feature of this soil. The normal soil type has been mapped where less than 10 per cent of the surface is taken up by rock.

A description and analysis of a profile sample have been included in the section on Podzolic soils earlier in the report.

Libi loam, steep rocky phase (Symbol $\frac{9}{\text{E-1}}$)

The hilly to mountainous rocky areas, especially those in the general vicinity of Mt. Rona are occupied by an intricate mixture of soils of which Libi loam is the most extensive. Such areas are mapped as Libi loam, steep rocky phase. Pegno gravelly loam and Rona loam are two of the common associated soils. In general Pegno soils occur on the upper slopes and summits whereas Rona loam is found on the lower slopes where the materials are deeper. Areas of very rocky mountainous land are included in this phase.

Patches of this land where the soil is deeper are used for native food crop production. In general however this land should only be used for pasture or forestry.

Loda clay loam (Symbol $\frac{14}{\text{C-1}}$)

A Latosol soil with an orange cast but developed on materials derived in part from laterite has been found on the lower often somewhat concave slopes of the Shari River area. It is most prevalent in the western part of the area where it occurs in close association with the Mboro and Kampala soils. These lower slopes are gently sloping to moderately steep. Vegetation is rank as a rule and is composed largely of Pteris fern, Pennisetum spp. grass and some palm. Erythrina is also common.

The surface 10 cm or so of this soil is a black moderately acid clay loam with a granular or crumb structure. Below this subhorizon the dark reddish brown weakly granular moderately acid clay loam extends to about the 40 cm depth to merge into the dark red clayey B_1 horizon with a weakly developed friable subangular structure. The B_2 horizon which comes in at about 80 cm assumes a somewhat darker reddish brown has a soft friable weakly subangular structure. Some dark reddish brown moderately firm aggregates or pseudo concretions are present. A red or dark red friable clay parent material is encountered at about the two meter depth.

Loda clay loam is an inextensive soil generally occupying small areas on the lower slopes along the drainage ways. It is a relatively fertile soil and could be used for cultivated native food crops in the area.

A profile sample of Loda clay loam (Profile No. 669) is described below and the available analytical data are included.

Location:	Western part, Shari River area.
Position:	Lower part of 15 per cent slope.
Vegetation:	Pteris fern, Pennisetum spp. Palms, Erythrina.

A_{11}	0-10 cm	Black clay loam 5 YR 2/1 (moist), 5 YR 2/1 (dry). Moderately developed crumb structure. Roots abundant.
A_{12}	10-21	Dusky red clay loam 2.5 YR 2/2 (moist) 5 YR 3/2 (dry). Weakly developed coarse granular structure. Roots abundant.
A_{13}	21-41	Dark reddish brown clay loam 2.5 YR 2/4 (moist) 2.5 YR 2/4 (moist) 2.5 YR 5 YR 3/4 (dry). Moderately developed fine subangular structure. Moderately friable. Many roots.
B_1	41-70	Dark reddish brown clay. 2.5 YR 3/4 (moist) 2.5 YR 3/6 (dry). Moderately developed fine subangular structure. Moderately friable (dry).
B_{21}	70-85	Dark reddish brown clay 2.5 YR 2/4 3/4 (moist) 2.5 YR 3/4 (dry). Moderately developed fine subangular structure. Moderately friable (dry). Roots common. This is the upper transition of the "dark horizon".

B_{21}	85-158	"Dark horizon". Dark reddish brown clay 2.5 YR 2/4 (moist) 2.5 YR 2/4 (moist) 2.5 YR 3/4 2/4 (dry). Fine friable subangular structure. Occasional moderately firm dark reddish brown aggregates or pseudo concretions.
B_{23}	158-200	Lower part of "dark horizon". Dark reddish brown clay 2.5 YR 3/4 (moist) 2.5 YR 3/4 (dry). Very weakly developed fine subangular structure. Soft friable (moist). Some moderately firm aggregates. Roots present, tend to show lateral spreading.
B_3	200-280	Dark red friable clay. 2.5 YR 3/6 (moist) 2.5 YR 3/6 (dry). Very weakly developed fine to medium subangular structure. Some roots present.
C	280-420	Dark red friable clay. 2.5 YR 3/6 (moist) 2.5 YR 4/6 3/6 (dry). Some detrital laterite pebbles and quartz fragements.

Analysis of Profile No. 669 - Loda Clay Loam
(Data by INEAC - Yangambi)

Horizon	Depth (cm)	pH	Carbon %	Nitrogen %	Exchangeable bases ME/100 grs	Exchangeable calcium ME/100 grs
A_{11}	0-10	5.9	2.86	0.348	22.9	14.7
A_{12}	10-21	5.9	2.57	0.191	13.0	7.4
A_{13}	21-41	5.6	1.45	0.089	4.9	2.3
B_1	41-70	5.3	0.86	0.075	4.2	1.7
B_{21}	70-85	5.1	1.16	0.071	4.0	0.9
B_{22}	85-158	5.0	1.14	0.053	3.6	0.9
B_{23}	158-200	5.0	0.75	0.036	3.9	0.7
B_3	200-280	5.0	0.47	0.024	4.4	1.9
C	280-420	5.2	0.16	0.018	4.2	1.0

Loluda loam (Symbol $\frac{26}{B-1}$)

Loluda loam includes all of the Gray Hydromorphic soils mapped in the area. These soils have developed under imperfect or poor drainage and as a rule occur on narrow gentle (usually less than 8 per cent) foot slopes bordering the drainageways. These areas are seldom more than 50 meters wide but may be of considerable length. Savanna with Pennisetum, and Hyparhennia spp. prevailing is the normal cover. Cymbopogon and Digitaria grasses are common on the disturbed areas.

A very dark gray surface soil, a lighter colored grayish subsurface and a brownish mottled B horizon are characteristic of this type. The A_1 horizon which is about 30 or 40 cm thick is a very dark gray moderately granular loam or fine sandy loam. This grades into a lighter colored (generally gray, grayish brown or light yellowish brown) loamy A_2 horizon with a weakly to moderately developed moderately friable subangular structure. It may grade through a mottled A_3 horizon to merge into a firm, clayey strongly mottled B horizon at about 90 cm. The grayish mottled, coarser textured C horizon comes in at about two meters or somewhat deeper. Generally the soil material is less weathered than that of the associated Latosols so considerable weatherable minerals are encountered. A description of a profile sample and some analytical data are given earlier in the report when the Gray Hudromorphic soils were discussed.

A considerable range of characteristics is permitted in this soil type. The A_2 horizon may be yellowish brown or reddish gray in some cases, while the B horizon may be dark yellowish brown, dark grayish brown or even yellowish red. Mottling may be encountered in the lower A_2 or anywhere in the B horizon.

Loluda loam is generally less acid than the associated Latosols. The A_1 horizon is medium to slightly acid (pH 5.5 to 6.5) while the acidity of the A_2 and B horizons range from a pH of 5 to about 6. It was observed that this type is somewhat more acid where it is associated with soils developed on materials derived in part from granitoid rocks.

It is a fertile soil but because of its limited extent is unimportant agriculturally. Most cultivated crops should do well on it where it is convenient to utilize it in this fashion.

Luga loam (Symbol $\frac{31}{D\text{-}1}$)

The Latosol soil developed on the friable moderately deep medium textured materials derived largely from a complex of metamorphic rocks and some granites are included in this type. It has been mapped extensively in the eastern and northeastern parts of the area where it is a common soil on the hillsides. Usually the slopes on which it occurs range from about 14 to about 18 per cent although it occurs to some extent on more gentle and some steeper slopes as well. Savanna in which Hyporrhenia and some Pennisetum spp. prevail is the main cover where it has not been disturbed greatly. Much of this soil has been grazed intensively however so post cultural species are common.

The A_{11} horizon is a very dark gray moderately to slightly acid loam or light clay loam with fair granular or crumb structure. It is generally about 12 to 15 cm. thick. The dark reddish brown A_{12} and A_{13} are more acid and have a weak coarse granular structure. These horizons grade into the red or reddish brown B_1 at about 40 cm. As a rule the latter horizon has a slightly higher clay content, a weakly developed subangular structure and carries an appreciable quantity of very fine and fine sand in the sand fraction. This horizon merges gradually into the darker reddish B_2 at a depth of about 1 meter. Outside of the darker reddish color its texture and structure is similar to that of B_1. A rather firm "stone line" up to 50 cm. thick with much coarse skeletal material (predominately quartz and quartzite) and a reddish clayey matrix is usually encountered in this horizon. The "stone line" tapers off into red or reddish brown clayey lower solum which in turn fades into the clayey sometimes gritty clayey and often micaceous parent material at about the two meter depth. The reddish color of the B horizon tends to have a brownish cast which distinguishes it from the Rona soils which generally have an organge cast. The C horizon often has a slightly purlish or pinkish appearance.

Luga loam mapped in the general area southeast of Luga Mission appears to carry appreciable fine and very fine sand. According to the limited use for cultivated crops in this area it is apparently less fertile here than in other parts of the area. This soil type mapped north and west of Tshomba Mission for about three kilometers appears to have a very friable consistence and weaker and less stable structure which may account for the serious erosion noted in this area.

Normally Luga loam appears to be at least moderately fertile and could be utilized for all cultivated native food and plantation crops. The topsoil is only moderately to slightly acid (pH 5.7 to 6.2) and has a fairly high level of exchangeable bases (about 15 to 20 milliequivalents) of which more than half is calcium. Reaction of B horizons while generally acid, (pH 5.0 to 5.3) is less so than that of most of the other Humic Red Latosols.

Profile No. 631 sampled about three kilometers southeast of Luga Mission has been described and analyzed. The results are given below.

Location:	3 k. southeast of Luga.
Position:	Middle of long (about 200 meters) 16 per cent slope.
Vegetation:	Native pasture.

A_{11}	0-15 cm.	Very dark gray loam, 5 YR 2/1 (moist) 5 YR 3/1 (dry). Moderately developed fine crumb structure.
A_{12}	15-26	Dark reddish brown loam. 5 YR 3/2 (moist) 5 YR 4/2 3/2 (dry). Moderately developed medium granular structure. Well developed granular when dry.
A_{13}	26-43	Dark reddish brown loam, 2.5 YR 3/3 (moist) 5 YR 4/3 (dry). Friable, fine to medium subangular structure.
B_{11}	43-73	Reddish brown loam 2.5 YR 4/4 3/6 (moist) 5 YR 4/6 5/6 (dry). Weakly developed fine to medium subangular structure. Friable. Roots common.
B_{21}	73-93	Transition to "dark horizon". Dark red light clay loam, 2.5 YR 3/6 4/6 (moist) 5 YR 4/6 (dry). Weakly developed fine to medium subangular structure. Friable. Roots common. Horizon boundaries gradual.
B_{22}	93-120	"Dark horizon". Dark reddish brown clay. 2.5 YR 3/4 (moist) 5 YR 4/6 (dry). Coatings on some faces 5 YR 4/3 (dry). Moderately developed fine to medium subangular structure when dry.
B_{23}	120-145	"Dark horizon". Dark reddish brown gritty clay. 2.5 YR 3/4 (moist) 5 YR 5/6 (dry). Weakly developed fine to medium subangular structure. Friable. Some streaks of quartz grit and fragments.

B_{2u} 145-200 "Stone line". Firm gravelly loam. Red clayey matrix between quartz grit and fragments and some fragments of dark weathered schist. 5 YR 2.5 YR 5/8 (dry).

B_3 200-230 Dark red clay loam. 2.5 YR 3/6 (moist) 5 YR 2.5 YR 5/6 (dry). Fine to medium moderately developed subangular structure. Some fine white mica and small yellow fragments that appear to be weathered basic rock.

C 230-430 Weak red micaceous clayey material with some grit. 10 R 5/4 4/4 (moist) 5 YR 6/3 (dry).

Analysis of Profile No. 631 - Luga Loam
(Data by INEAC - Yangambi)

Horizon	Depth (cm)	Clay % 2 u	Silt % 2-50 u	Sand % 50-2000 u	Coarse Material % 2 mm	pH	Carbon %	Nitrogen %	Exchangeable bases ME/100 grs	Exchangeable calcium ME/100 grs	T value pH 6.7	T value pH 5.1
A_{11}	0-15	43.2	16.4	40.4	- -	5.9	3.12	0.260	15.0	7.1	16.9	15.3
A_{12}	15-26	44.8	14.1	41.1	- -	5.8	2.45	0.138	8.0	2.9	9.6	8.4
A_{13}	26-43	45.2	13.5	41.1	- -	5.6	1.44	0.102	5.0	1.7	7.3	6.1
B_{11}	43-73	46.6	14.0	39.4	- -	5.3	0.67	0.061	4.5	0.7	5.4	4.3
B_{21}	73-93	55.9	11.5	32.6	- -	5.2	0.70	0.051	4.5	1.0	6.9	5.6
B_{22}	93-120	60.8	10.6	28.6	- -	5.2	0.68	0.045	5.3	1.0	7.6	3.8
B_{23}	120-145	52.4	17.6	30.0	70.0	5.3	0.52	0.034	5.7	1.6	6.7	4.9
B_{24}	145-200	61.8	9.2	29.0	66.8	5.3	0.23	0.019	5.7	1.2	4.2	3.3
B_3	230-430	38.1	28.7	33.2	16.5	5.3	0.10	0.029	4.2	1.0	5.1	- -

Luga loam, moderately eroded phase (Symbol $\frac{31}{D-2}$)

This is a very common phase of Luga loam. Generally the topsoil is about 10 to 12 cm. thick and has a very dark or dark gray topsoil instead of the very dark gray or black.

Luga loam, severely eroded phase (Symbol $\frac{31}{D-3}$)

Many areas of Luga loam have suffered severe erosion. A thin dark gray surface or, where it has been greatly disturbed, a dark reddish gray surface is a common characteristic.

Luga loam, gently sloping phase (Symbol $\frac{31}{B-1}$)

This phase is not extensive and is found on some of the gently sloping summits where the materials are deeper. A somewhat higher clay content in the upper solum than found on slopes is the only difference that has been noted.

Luga loam, severely eroded, gently sloping (Symbol $\frac{31}{B-3}$)

The nearly level or gently sloping summits where this phase is found commonly are frequently the sites of native villages. The topsoil is generally reddish colored.

Marsh (Symbol 27)

Areas in perennial marsh. Papyrus and Marsh grass are the main vegetation forms.

Mboro clay loam (Symbol $\frac{12}{B-1}$)

Included in this type are the Humic Red Latosol soils developed on deep friable clayey materials derived in part at least from laterite but which carry appreciable quantities of medium and coarse quartz sand. It is a common and an extensive soil type in west Shari River area where it occupies the nearly level summits and some of the moderate slopes. Loudetia savanna is prevailing vegetation on these soils.

The very dusky red or dark reddish brown clay loam topsoil is generally 12 to 15 cm. thick and tends to have a slightly hummocky micro-relief. A weakly to moderately developed granular

structure is common. This topsoil grades through dark reddish brown or reddish brown subsurface into the dark red B_1 horizon at about 40 cm. The latter having a clayey texture and a weakly developed fine to medium friable subangular structure. It begins to assume a somewhat darker color at about 75 cm. and at about 1 meter depth merges into the dusky red or dark reddish brown clayey B_2 horizon. This horizon as a rule has a very weakly or weakly developed very friable subangular structure that breaks down very easily into weak fine crumb. Some firm dark reddish brown aggregates or pseudo concretions make their appearance in this horizon. At about the two meter depth the B_2 horizon passes into the red or dark red B_2 horizon which in turn fades into the red parent material at about two and one half meters. The B_3 horizon has a weakly developed fine to medium subangular structure and often has appreciable, small firm aggregates or pellets.

The dusky red or dark red color of the soil (10 R Munsell chart) is most pronounced on the nearly level or gentle slopes near the Shari River. It is generally a somewhat lighter red on the side slopes. This lighter red color becomes more pronounced to the west when this type merges into the Kampala series. This soil differs from those of the Shari clay loam in having moderate quantities of medium and coarse quartz sand (over about 10 per cent) in the solum. They differ from the Kampala soils with which they are closely associated in that the latter have a red instead of a dusky red solum. (The red color of these three soils falls on the 10 R Munsell chart). A description of a sample profile of Mboro clay loam and some analytical data have been included in the discussion of Humic Red Latosol soils earlier in the report.

Mboro clay loam is easily susceptible to deterioriation and is of low to medium fertility. It should be used primarily for grazing with a limited use for cultivated native food crops such as manioc. Sweet potatoes do not seem to do very well. Plantation crops should not be grown on this soil.

Mboro clay loam, moderately eroded phase (Symbol $\frac{12}{B-2}$)

The topsoil of this phase is generally between 7 and 12 cm. thick and has a dark reddish brown color. It often has a hummocky micro-relief with hummocks up to about 10 cm. high.

Mboro clay loam, severely eroded phase (Symbol $\frac{12}{B-3}$)

This phase is characterized by a dark reddish brown or reddish brown thin topsoil and a hummocky relief. Hummocks up to 20 cm. high are common.

Mboro clay loam, moderately eroded, sloping phase (Symbol $\frac{12}{C-2}$)

Some areas of moderately eroded Mboro clay loam occurred on slopes up to 15 per cent. This was mapped as a sloping phase.

Munzi gravelly loam (Symbol $\frac{40}{D-3}$)

Throughout the western part of the area in locations where lateritic material may be found at or near the surface the soils are shallow and show little development. Such soils classed as Lithosols are identified as Munzi gravelly loam. They are of very limited extent.

Soil of this type consists of a dark reddish brown gravelly loam A horizon where the gravelly is mostly pebbly laterite. This surface soil may be up to 30 cm. thick and lies on either massive or detrital pebbly laterite substratum. The massive laterite may be an extremely hard reddish ferruginous material while in other cases it may be a moderately hard somewhat friable reddish material mottled with yellow and white splotches. Loudetia savanna is the common vegetation.

Munzi gravelly loam on the steep upper slopes is often severely eroded so the surface is reddish brown and littered with laterite gravel. Only the severely eroded type has been mapped on the slopes.

Munzi gravelly loam, greatly sloping phase (Symbol $\frac{40}{B-2}$)

Some of these shallow gravelly soils were found in narrow strips with gentle slopes fringing the headwaters of some of the drainageways. In other cases these soils were found in small areas on the gently sloping detrital laterite hilltops. Such soils were mapped as the gently sloping moderately eroded phase of Munzi gravelly loam. Only the moderately eroded phase was mapped. The topsoil has a dark reddish brown color but as a rule laterite pebbles litter the

surface in spots indicating some removal.

Soils of this type have low agricultural value and should only be used for grazing.

Nguma stony loam (Symbol $\frac{53}{E-1}$)

The stony summits or ridges of the dark basic rock dikes generally have a thin poorly developed soil mantle. This Lithosol occupies the pockets and spaces between the rocks and consists of a very dusky red clay loam with a moderately developed crumb structure. Where it is more than 20 cm. thick it is merged into dark reddish brown friable clay which in turn is underlain by partially weathered basic rock within a meter of the surface. Small patches of Djuda clay loam are often found in areas of Nguma soils.

It is a soil of high fertility but because of its stony nature is not suited for cultivated crops.

Niagaki gravelly loam (Symbol $\frac{30}{B-1}$)

This type includes the Lithosols on the partially weathered hard rock materials such as vein quartz, quartzite, schists or granites. The soil consists of a very dark or dark gray gritty loamy material of variable depth which in some cases may reach 30 cm. It is underlain by the rock materials listed above some of which may be partially weathered. Niagaki gravelly loam which is found more frequently on the gently sloping ridge or hilltops is underlain by quartz and quartzite gravels and fragments. It is a drouthy soil and should be used for grazing only.

Niagaki gravelly loam steep phase (Symbol $\frac{30}{E-2}$)

The lithosol on the steeper slopes generally have a dark gray gritty loam surface soil usually less than 20 cm. thick over hard rock or grayish brown gritty coarse material which in turn is underlain by rock within a meter or so of the surface. The surface is usually stony with the soil occupying the spaces or pockets between the rock outcrops. Because of its drouthiness and the steep slopes its use should only be limited grazing. Excessive grazing may lead to serious erosion.

Pegno gravelly loam (Symbol $\frac{8}{B-1}$)

Moderately shallow, medium to coarse textured soils with a somewhat lighter colored subsurface occur on some of the crests and steeper upper slopes in the areas of metamorphic and granitoid rocks. Such soils have been mapped as Pegno gravelly loam. These soils are considered to be weakly podzolic with poor profile development.

This is an extensive type in central, eastern and northeastern parts of the area. It is found on many of the slightly convex hilltops and steeper slopes where the materials are inclined to be shallow and somewhat coarse textured. A savanna in which some of the more xerophytic species are common constitutes the native vegetation. Much of this soil has either been grazed heavily or disturbed by cultivation so the vegetation is often mixed.

The very dark gray, granular slightly and/or neutral topsoil, the A_{11} horizon, is from 10 to 20 cm. thick and is generally a loam or gravelly loam in texture. The reddish brown or yellowish red A_2 horizon comes in at about 30 cm. Its texture is variable and may range from a light gritty or gravelly loam to a clay loam with considerable coarse material. The depth is likewise variable but generally it passes into the coarse skeletal material with clayey matrix within one meter of the surface. This horizon is the B_{1u} and constitutes the stone line or it may be the coarse resistant material that often appears to accumulate above weathered rock. Fragments of quartz, especially vein quartz, and quartzite are common. Fragments of other rocks may also be present. The next horizon down the B_{2u} likewise carries some coarse material but generally has a higher clay content. The color may be red, reddish brown or yellowish red. It has a weak subangular structure and is often rather firm in the upper part. At about two meters this horizon fades into the reddish or yellowish brown or pinkish parent material which is often gritty and micaceous.

In some respects this soil resembles Libi loam which shows somewhat more pronounced podsolic characteristics. The A_2 of Libi loam is yellowish brown to yellowish red and is coarser in

texture. Further the B horizon of Pegno soils are red, reddish brown or dark red, whereas those of Libi loam are reddish yellow or reddish brown.

This soil type is moderately to slightly acid and appears to have a high level of mineral plant nutrients. It is droughty however so should not be used for long season cultivated crops. It should do very well in pasture during the wetter periods.

Much of this soil in the western part of the area has been heavily grazed so the surface has deteriorated through erosion and breakdown of structure.

A profile sample of Pegno gravelly loam (Profile No. 523) taken about two kilometers southwest of Tshombe Mission has been described and analyzed. The data follows:

Location: 2 km. southwest of Tshombe Mission.
Position: Top of nearly level summit, about 100 meters wide.
Vegetation: Savanna, Hyperrhenia and Pennisetian spp.

A_{11} 0-10 cm Very dark gray loam. 5 YR 3/1 (moist) 5 YR 3/1-3/2 (dry). Moderately developed medium to coarse granular structure. Roots abundant.

A_{12} 10-17 Reddish brown gravelly loam 5 YR 3/2 (moist) 5 YR 3/2-2/2 (dry). Weakly developed fine to medium subangular structure which breaks up easily into medium crumb. Roots relatively abundant.

A_{13} 17-33 Dark reddish brown gravelly loam 5 YR 3/3 (moist) 5 YR 3/4 (dry). Considerable quartz grit. Weakly developed fine subangular structure. Friable. Roots relatively abundant.

A_2 33-48 Reddish brown gravelly loam. 2.5 YR 3/4 (moist) 5 YR 3/4-4/4 (dry). Quartz grit present. Moderately developed fine subangular structure. Friable. Roots numerous.

B_{14} 48-65 Stone line. Skeletal material; quartz and quartzite fragments. Reddish brown clayey matric 2.5 YR 3/6-4/6 (moist) 5 YR 4/4-4/6 (dry). Roots numerous.

B_{214} 65-100 Yellowish red gritty clay loam 2.5 YR 4/6-4/8 (moist) 5 YR 2.5 YR 5/8 (dry). Very firm in place. Friable, weak, fine to medium subangular structure when removed. Roots concentrated along cracks.

B_{224} 100-215 Red gritty clay 2.5 YR 4/6-4/8 (moist) 2.5 YR 5/6-6/8 (dry). Weak subangular structure. Friable. Only slightly firm in place.

C 215-280 Mixed materials, consisting of white or gray kaolinitic material, weathered reddish gray schisty material and quartz sand. Streaks of red clayey material penetrate from above.

Analysis of Profile 523 - Niagaki Gravelly Loam
(Data by INEAC - Yangambi)

Horizon	Depth	Clay % 2 u	Silt % 2-50 U	Sand % 50-2000 u	Coarse Mat'l %	pH	Carbon %	Nitrogen %	Exchangeable bases ME/100 grs	Exchangeable calcium ME/100 grs.
A_{11}	0-10	30.6	21.1	48.4	- -	6.5	3.70	0.253	21.2	13.6
A_{12}	10-17	36.9	14.8	48.3	4.9	6.0	2.17	0.173	10.3	6.3
A_{13}	17-33	37.5	14.2	48.3	7.1	6.0	1.13	1.100	7.6	5.0
A_2	33-48	38.5	14.7	49.4	9.2	6.0	0.62	0.066	6.1	4.1
B_{14}	48-65	35.9	12.5	51.6	77.2	6.0	0.61	0.063	5.7	- -
B_{214}	65-100	51.1	8.7	40.2	55.7	6.2	0.17	0.032	7.0	- -
B_{224}	100-215	48.5	16.9	34.6	25.5	6.3	0.17	0.023	6.2	- -
C	215-280	13.8	38.6	47.6	19.0	6.4	0.07	0.006	2.5	- -

Pegno gravelly loam, severely eroded phase (Symbol $\frac{8}{B-3}$)

Many of the hilltops and summits where this soil is found are or were occupied by native villages. This has led to heavy grazing, tramping and cultivation and to considerable soil degradation. The topsoil, A_{11} horizon, in such cases has a dark reddish gray or dark reddish brown color and is less than 10 cm. thick. Structure is generally weak granular or weak crumb. This soil should only be used for pasture.

Pegno gravelly loam, sloping phase (Symbol $\frac{8}{D\text{-}1}$)

Soils of this phase occur on moderate to strong slopes. The topsoil is relatively thick, being 15 cm. or more, has a loamy texture and a good granular structure. Occasional small outcrops of granite are encountered on this soil. It is widely used for sweet potatoes and manioc both of these crops appear to do well.

Pegno gravelly loam, moderately eroded sloping phase (Symbol $\frac{8}{D\text{-}2}$)

This is common and an extensive soil in the eastern part of the area where it occurs on strongly sloping topography. The loamy topsoil is about 12 cm. thick and has a very dark gray color. The A_2 horizon is generally a yellowish red or reddish brown loam or clay loam. Some moderately deep soils of the Luga series are included in the areas mapped as this phase. This soil should be used primarily for grazing with some limited use for native cultivated crops.

Pegno gravelly loam, severely eroded sloping phase (Symbol $\frac{8}{D\text{-}3}$)

A severely eroded phase of this type was found on the moderately steep to steep slopes. Such areas are identified as a severely eroded sloping phase.

Pegno gravelly loam, sloping rocky phase (Symbol $\frac{3}{D\text{-}1}$)

This phase is confined largely to the granitic area. The topsoil is somewhat thicker and darker, often black. It is also somewhat lighter textured generally being a light loam or heavier sandy loam. Numerous outcrops of granite occupying 10 per cent or more of the area are common to this phase. It is widely used by the natives for production of sweet potatoes.

Pegno gravelly loam moderately eroded rocky phase (Symbol $\frac{3}{B\text{-}2}$)

In some cases rock outcrops and boulders covered an appreciable part of Pegno gravelly loam on the gently sloping summits. Some of this soil has been affected by erosion to a moderate degree. Where the rocks occupied 10 per cent or more of the surface the areas are mapped as Pegno gravelly loam, moderately eroded rocky phase.

Rona loam (Symbol $\frac{1}{D\text{-}1}$)

This type includes Humic Red Latosol soil developed on the moderately deep, friable, medium textured materials derived largely from the granitoid rocks. It occurs most frequently on moderately steep slopes of about 14 to 18 per cent gradient though it is also found on more gentle as well as on steeper ones. Savanna with Hyparrhenia and Pennisetum spp. predominating is common vegetation on this soil type where it has not been disturbed recently. A large per cent of this soil type is used for cultivated crops.

This soil has a granular black or very dark gray moderately or slightly acid (pH around 6) loam topsoil A_{11} that is around 15 cm. thick. The dark reddish brown lower topsoil, A_{12} and A_{13} horizons, likewise has a loam texture but is somewhat more acid and tends to have a less developed but more coarse granular structure. It grades rather sharply into the acid (pH about 5) red, reddish brown or yellowish red upper subsoil (B_1) at about 40 cm. which in turn extends to about the one meter depth. This upper subsoil may contain somewhat more clay and when moist has a friable, weakly developed fine to medium subangular structure. This structure becomes more pronounced and more firm when dry and the soil assumes a hard or moderately hard consistence. The lower subsoil (B_2) is likewise acid but is somewhat darker being reddish brown, dark red or dark reddish brown when moist. The structure is similar to that of B_1 but the consistence is somewhat more fiable. A "stone line" which may be definite or diffuse is frequently encountered in this horizon hence the material is lower B_2 may be variable. As a rule it is less weathered than the material in the upper part of the solum.

Rona loam differs from Luga loam in that the latter is developed on moderately deep materials derived largely from a complex of metamorphic rocks. Luga loam is also reddish in the lower solum but has a slight brownish cast. It also contains more fine and very fine sand whereas in the Rona soil medium and coarse sand is more common.

Some variations of Rona loam have been mapped. In the general area about two kilometers northeast of Libi in another area a similar distance to the southwest the texture was

appreciably lighter. The topsoil is a fine sandy loam and the subsoil a loam. Some detrital laterite gravel is present in the stone line of this soil north of Kampala along the Golu-Gabu road and along the eastern edge of the Shari River basin.

This type differs from soils of the Aoda soils, also developed on materials derived largely from granitoid rocks in that the materials of the latter are relatively deep being at least two meters or more to "stone line".

This is a fairly extensive and an important soil type. It is widely used by the natives for the production of food crops such as sweet potatoes, manioc, eleusine and beans. Compared to other soils of the area it appears to have a high level of fertility and comparatively is highly productive for the crops mentioned. Analysis indicates that it has a moderately or slightly acid topsoil with considerable organic matter and a fairly high level of exchangeable calcium. The soil may be somewhat droughty where the slopes are steeper or where the stone line may be very coarse textured. It does appear to be fairly resistent to erosion, probably because of the good granular structure.

Areas mapped as Rona loam will have some inclusions of associated soils particularly Aoda loam and Pegno gravelly loam.

Rona loam, moderately eroded phase (Symbol $\frac{1}{\text{D-2}}$)

This phase of Rona loam is a common soil in the area around Mt. Rona and Nioka. Outside of the changes in A_1 horizon brought about by erosion this soil appears similar to the normal type. As a rule the surface soil is thinner averaging about 10 to 12 cm. It is also somewhat lighter colored and may be a very dark gray or a dark gray instead of black. Where it has been mixed intensively by cultivation it may have a dark reddish brown color. The structure may likewise show the effects of erosion and tends to be weak granular. The few tests made indicate that the topsoil is more acid than that of the normal type.

Rona loam, severely eroded phase (Symbol $\frac{1}{\text{D-2}}$)

The severely eroded phase has a thin very dark gray or dark gray A_1 horizon generally less than 8 cm. thick. Where mixing has been appreciable the surface may be a dark reddish brown. As in the moderately eroded phase the structure has been adversely affected and is often a weak granular or weak crumb. This phase is relatively inextensive and seems to be more prevalent in the transition areas between granitic and other materials. The moderately rocky but severely eroded areas of Rona loam are included in this phase.

Rona loam, gently sloping phase (Symbol $\frac{1}{\text{B-1}}$)

This phase occurs frequently on the gently sloping or nearly level summits and occasionally is found on the gently sloping hillsides. While it is closely similar to the normal type of Rona loam it is inclined to have a somewhat higher clay content in the subsoil. The stone line too is sometimes less pronounced. Much of this soil is or has been cultivated. In addition it seems to be a popular site for native villages. This intensive use has disturbed the soil appreciably so the color of topsoil is often a very dark gray instead of black. Areas that have been moderately eroded are included in this phase.

Rona loam, moderately rocky phase (Symbol $\frac{2}{\text{D-1}}$)

This is another common and extensive phase of Rona loam. It can be expected that since these soils are developed on only moderately deep materials there will be numerous occasions when the rock will appear at or above the surface. The soils included may range from Lithosols and Podzolic to deep Latosols. Generally the latter are a more frequent associate on the moderately rocky lower slopes while the others are more common on the upper slopes and hill-tops.

Soils of this category are as fertile and productive as the normal Rona loam. The moderately rocky conditions present no handicap as long as hand tillage is practiced. This would be a problem in case mechanized operations are adopted.

Rona loam, moderately rocky, moderately eroded phase (Symbol $\frac{2}{D-2}$)

Appreciable areas of the moderately rocky Rona loam have been affected by moderate erosion. The characteristics and use of this soil are similar to those of the Rona loam, moderately eroded phase.

Rona loam, gentle sloping, moderately rocky phase (Symbol $\frac{2}{B-1}$)

Soils of this phase are not extensive. Outside of being moderately rocky, it is similar to the Rona loam, gently sloping phase in solum characteristics and in use.

Setchama clay loam (Symbol $\frac{4}{B-1}$)

A Humic Red Latosol soil found on some of the nearly level or gently sloping high surfaces has been identified as Setchama clay loam. It has developed on dark red deep friable clayey materials. Zeu clay loam which has a somewhat brighter red solum is sometimes associated with this soil. Apparently Setchama clay loam has developed on mixed fine textured materials preserved on some of the older surfaces. Savanna with Hyparrhenia and Pennisetum spp. prevailing is the common vegetation.

The soil to a depth of about 15 cm. is a black clay loam with fine to medium moderately developed fine crumb structure. Grass roots are abundant.

Below the A_{11} horizon the soil becomes a little lighter colored changing to dark reddish brown weakly granular clay loam which in turn changes rather definitely at about 40 cm. to B_1. The latter horizon, a dark red or dark reddish brown clay with weakly developed subangular structure continues to about the 80 cm. depth where it merges gradually into the "dark horizon" the B_2. This is a dark reddish brown very friable clay with a weakly developed subangular blocky structure. This horizon and the one below has numerous medium to coarse subangular blocky moderately firm aggregates or pseudo concretions. They are of about the same color as the soil matrix although they may be somewhat darker reddish brown. The dark red or dark reddish brown B_3 fades gradually into the red friable clayey parent material at about the two and one half meter depth.

One of the distinguishing features of the soils of this type is the dark red or dark reddish brown color of the solum (falling on the 2.5 YR Munsell chart) compared to dark red or dusky red of the soils of the Shari and Mboro series. These soils carry only about 10 per cent or less of medium and coarse quartz sand which is less than the Aoda clay loam with which it is sometimes associated. Very fine and fine sand is more abundant.

The parent materials of Setchama soils resemble the parent materials of the other Latosols in color, consistence and texture but they are more acid. A pH below 4.6 has observed in this material. Most of the other materials have a pH value around 5.

Analyses and vegetation suggest that Setchama soils are comparatively fertile and could be used for all cultivated crops. It is of very limited extent however.

As an example of this soil type the description and analyses of profile No. 532 are given below:

Profile No. 532 - Setchama clay loam.
Location: 2 km. south of Rona Camp. 400 meters west of Rona Forest.
Position: Gently sloping (2 per cent) summit about 200 meters wide. Elevation 1768 meters.
Vegetation: Savanna: Pennisetum and Hyparrhenia spp.

A_{11}	0-15 cm.	Black clay loam. 5 YR 2/1 (moist) 5 YR 2/2 (dry). Moderately developed crumb structure. Roots abundant.
A_{12}	15-23	Dark reddish brown clay loam. 2.5 YR 3/2 2/4 (moist). 5 YR 3/2 (dry). Weakly developed coarse granular. Roots abundant.
A_{13}	23-38	Dark reddish brown clay loam. 2.5 YR 3/2-3/4 (moist). 2.5 YR 3/4 (dry). Weakly developed fine subangular structure. Friable. Roots common.

B_1	38-90	Dark red clay 2.5 YR 3/4-3/6 (moist) 2.5 YR 4/6 (dry). Weakly developed fine to medium subangular structure. Moderately firm in place. Roots common.
B_{21}	90-117	Upper "dark horizon" transition. Dark reddish brown clay. 2.5 YR 3/4 (moist) 2.5 YR 3/6 (dry). Weakly developed fine to medium subangular structure. Occasional dark reddish brown aggregate or pseudo concretions. Boundaries diffuse.
B_{22}	117-185	"Dark horizon". Dark reddish brown clay. 2.5 YR 3/4 (moist) 2.5 YR 3/4-3/6 (dry). Weakly developed fine to medium subangular blocky structure. Very friable. Dark reddish brown to very dusky red moderately firm aggregates or pseudo concretions common. Some roots. Boundaries diffuse.
B_{23}	185-210	Dark red clay. 2.5 YR 3/6-3/4 (moist) 2.5 YR 3/6 (dry). Weakly developed fine to medium subangular structure. Friable. Dark reddish brown, moderately firm aggregates or pseudo concretions common. (Most abundant in profile). Roots common.
B_3	210-250	Dark red clay 10 R 3/6 (moist) 2.5 YR 4/6 (dry). Very weakly developed fine to medium subangular structure. Slightly firm in place but very friable when removed.
C	250-300	Dark red clay 10 R 4/6-3/6 (moist) 2.5 YR 10 R 3/6(dry). Some roots present.
	300-375	Dark red very friable clay 10 R 3/6-4/6 (moist) 2.5 YR 10 R 4/6 (dry). Roots becoming scarce.
	375-450	Red friable clay 10 R 3/6-4/6 (moist) 2.5 YR 10 R 4/6 (dry).
Du	450-500	"Stone line" quartz fragments and detrital laterite pebbles.
D	500-660	Yellow and red clayey material. Quartz fragments and laterite concretions.
D	660-700	Red clayey material mixed with small quartzite and quartz fragments. Micaceous feel.

Analysis of Profile No. 432 - Setchama Clay Loam
(Data by INEAC - Yangambi)

Horizon	Depth	Clay % 2 u	Silt % 2-50 u	Sand % 50-2000u	pH	Carbon %	Nitrogen %	Exchangeable bases ME/100 grs.	Exchangeable calcium ME/100 grs.
A_{11}	0-15	26.2	40.6	32.0	5.6	4.10	0.381	19.0	10.8
A_{12}	15-23	39.3	25.1	33.6	5.3	2.15	0.223	7.9	
A_{13}	23-38	44.6	17.2	36.1	5.2	1.13	0.118	4.1	
B_1	38-90	54.9	15.5	31.4	5.0	0.49	0.069	4.0	
B_{21}	90-117	55.0	11.3	33.2	4.6	0.47	0.051	3.5	
B_{22}	117-185	61.2	11.5	28.1	4.5	0.57	0.048	3.7	
B_{23}	185-210	59.6	12.1	28.4	4.3	0.49	0.042	4.0	
B_3	210-250	59.9	10.1	30.7	4.6	0.32	0.047	4.2	
C	250-300	60.9	13.5	25.9	4.2	0.23	0.030	4.4	
	300-375	60.1	11.9	25.2	4.4	0.12	0.024	4.3	
	375-440	61.1	15.0	21.9	4.7	0.11	0.019	3.5	
	440-450				4.1	0.11	0.022	4.3	
D_4	450-500				4.8	0.13	0.016	4.2	
D	500-660				4.9	0.09	0.016	3.6	
	600-700				4.8	0.09	0.017	4.0	

Setchama clay loam, severely eroded phase (Symbol $\frac{4}{B-3}$)

Some severely eroded areas of Setchama clay loam were found in the area. This phase is characterized by having a very dark gray surface usually less than 8 cm. thick or where it has been disturbed the color of the topsoil is either a reddish brown or dark reddish brown.

Shari clay loam, moderately eroded phase (Symbol $\frac{10}{B-2}$)

Shair clay loam includes the Humic Red Latosol soil developed on the deep, smooth, fine textured dark red friable materials derived in part at least from laterite. This is an extensive soil type occupying the extensive nearly level summits and gentle slopes in the upper Shari River watershed and area to the north. Loudetia savanna is the common vegetative cover.

The dark reddish brown clay loam surface soil is about 7 to 12 cm. thick where it has been preserved though very much of this type has been moderately eroded. Hummocks up to 10 cm.

high around grass bunches are numerous. It has moderately developed medium to coarse granular structure. This horizon grades through dark reddish brown or dusky red clay loam subsurface (A_{12} and A_{13} horizons) into the red or dark red B_1. The latter has a clay texture and when moist a weakly developed friable fine to medium subangular structure. When dry the structure is more pronounced usually being moderately well developed subangular blocky. At a depth of about 90 cm. this horizon gives way gradually to the "dark horizon" the dark reddish brown or dusky porous red B_2. The latter extends to about the two meter depth where it merges gradually into the dark red or dark reddish brown B_3 horizon. The structure of B_2 when moist is usually a very friable, very weakly developed subangular blocky which breaks up easily into weak fine crumbs. Moderately firm dark reddish brown aggregates or pseudo concretions are usually encountered in the dark horizon. The B_3 horizon fades into the red or dark red friable clayey parent material somewhere between the two and three meter depth. Some small (about one centimeter in diameter) red or dark red firm spheroid pellets or concretions may occur in the B_3 and the upper parent material.

Where the soil has not been eroded the surface is reddish black or dark reddish brown to a depth of 12 to 15 cm. Since only limited areas were present they were included with the moderately eroded phase.

Soil of the Shari series can be recognized rather easily because of dark red or dusky red solum and parent material (10 R on the Munsell color chart) their fine texture and their friable or very friable consistence. They differ from the Mboro soils, which they resemble in color and consistence, primarily in having appreciably less medium and coarse sand. They contain less than 10 per cent of this fraction whereas the Mboro soils may have over 20 per cent of these fractions. Dadwoda soils which are closely associated with Shari clay loam occur on the slopes more frequently and have a red instead of dark red solum though it still falls on the 10 R Munsell chart.

Shari clay loam is only moderately fertile even when not seriously affected by erosion. It is easily erodible. Controlled grazing is probably the best use for it.

A description of one of the profile samples (Profile No. 596) taken about 6 km. south west of Rona forest is given below together with the analytical data.

Location:	About 6 km. south west of Rona Forest.
Position:	Extensive nearly level summit - about 500 meters wide. Slope 1% to northeast. Elevations 1668 meters.
Vegetation:	Loudetia savanna.

A_{11}	0-15 cm.	Reddish black clay loam 10 R 2/1 (moist) 5 YR 3/1 (dry). Coarse granular. Roots abundant.
A_{12}	15-25	Dusky red clay loam. 2.5 YR 3/2 (dry). Coarse granular (dry). Roots abundant.
A_{13}	25-40	Dark reddish brown clay loam. 2.5 YR 3/3 (dry). Coarse granular. Many roots.
B_1	40-85	Dusky red clay 10 R 3/3 (moist) 2.5 YR YR 4/8 (dry). Weakly developed fine subangular structure when moist. Moderately well developed fine subangular when dry. Some dark streaks apparently organic matter along root channels.
B_{21}	85-105	Upper "dark horizon" transition. Dusky red clay 10 R 3/2 (moist) 2.5 YR 4/6 (dry). Weakly developed fine subangular structure. Friable breaking up easily into fine crumb. Many roots.
B_{22}	105-175	"Dark horizon". Dusky red clay 10 R 3/2 (moist) 2.5 YR 3/6 (dry). Very weakly developed fine to medium subangular blocky structure. Very friable breaking up easily into fine crumb. Porous and soft in place when moist.
B_{23}	175-200	"Dark horizon" lower transition. Dusky red clay 10 R 3/4 (moist) 2.5 YR 4/6 (dry). Very weakly developed fine to medium subangular breaking up easily into weak fine crumb. Very friable. Roots present. Few moderately firm aggregates.

B_3	200-240	Dusky red clay 10 R 3/5 (moist) 2.5 YR 10 R 3/6 (dry). Very weakly developed fine to medium subangular structure, breaking easily to weak fine crumb. Some firm subangular aggregates or pseudo-concretions. Roots present.
C	240-490	Dark red clay 10 R 2.5 3/6 4/6 (moist) 10 R 2.5 YR 4/8 (dry). Friable.
D_u	490-580	"Stone line." Red gravelly clay. 10 R 4/6-3/6 (moist) 2.5 YR 5/8 (dry). Much detrital bean shaped laterite and quartz fragments.
D	580-800	Red and yellow clayey material mixed with auger. Has talcose feel. Some quartz sand present.

Analyses of Profile No. 596 - Shari Clay Loam
(Data by INEAC - Yangambi)

Horizon	Depth (cm)	Clay % 2 u	Silt % 2-50 u	Sand % 50-2000u	pH	Carbon %	Nitrogen %	Exchangeable bases ME/100 grs	Exchangeable calcium ME/100 grs	T Value pH 6.7	T Value pH 5.1
A_{11}	0-15	48.2	17.2	34.6	5.3	2.21	0.205	7.5	3.1	13.3	10.9
A_{12}	15-25	54.8	9.2	36.0	5.1	1.63	0.139	3.5	0.5	12.0	8.9
A_{13}	25-40	54.7	11.3	34.0	4.9	1.35	0.110	3.0	0.4	10.1	8.0
B_1	40-85	59.2	11.2	29.6	5.1	0.97	0.091	3.6	0.6	7.7	5.6
B_{21}	85-105	56.6	10.5	32.9	5.0	0.82	0.072	3.8	0.6	11.9	10.9
B_{22}	105-175	57.7	10.2	32.1	5.1	0.77	0.052	4.4	1.0	7.2	6.2
B_{23}	175-200	62.4	9.2	28.4	4.8	0.55	0.052	4.3	1.2	7.6	5.2
B_3	200-240	62.4	9.5	28.1	4.8	0.47	0.042	4.6	1.5	6.4	4.2
C	240-490	63.0	11.8	25.2	4.9	0.17	0.019	4.6	1.2	5.2	3.7
D_u	490-580	65.5	16.3	20.3	5.2	0.09	0.021	4.9	1.1	5.0	4.0
D	580-800	66.2	13.3	20.5	5.2	0.22	0.015	4.8	0.6	--	--

Shari clay loam, severely eroded phase (Symbol $\frac{10}{B-3}$)

This phase has a thinner and lighter colored topsoil. It has a dark reddish brown, reddish brown or dark reddish gray color as a rule and is usually less than 10 cm. thick. Weakly developed coarse granular structure is common. Hummocks up to 20 cm. are frequent.

Tshombe clay loam (Symbol $\frac{37}{C-1}$)

This type includes the Latosol soils developed on the deep medium to moderately fine textured friable materials derived largely from a complex of metamorphic rocks generally quartzites and schists. Some parts of the area have had additions of materials derived from granitic rocks. Slopes on which this soil occurs are generally moderately steep ranging from 12 to about 18 per cent though these soils have been mapped on more gentle slopes as well. They are closely associated with soils of the Luga series the latter occupying the somewhat steeper or upper slopes. Savanna is which Hyparrhenia grass prevails is the common cover in the less disturbed areas. Considerable over grazing has occureed in the area where these soils are found so much of the present cover consists of post cultural species.

The soil profile of the Tshombe series consists of a relatively thick, very dark gray or black topsoil, a reddish upper subsoil, a darker reddish lower subsoil and a red parent material. Often the red color of this soil has a brownish cast. The very dark gray or black moderately granular loam or clay loam A_{11} horizon is from 12 to 20 cm. thick. This dark topsoil grades through the dark reddish brown granular subsurface horizons to terminate with a clear boundary at about the 40 cm. depth. The red clay loam B_1 horizon which continues to about the 75 cm. depth has a weakly developed friable subangular structure. Below this depth the soil assumes a darker color gradually to merge into the dark reddish brown clayey B_2 the "dark horizon", at about one meter below the surface. The latter horizon which continues to about the two meter depth has a weakly developed friable crumbly subangular blocky structure. Some of the structure units show dark coatings similar to the color of the dark reddish brown moderately firm aggregates or pseudo concretions found in this horizon. The B_2 horizon merges gradually into dark red or dark reddish brown friable clayey B_3 which in turn passes into the red friable parent material at about 225 cm. Numerous dark reddish brown moderately firm aggregates or pseudo concretions are found in the B_3. Some red or

reddish brown form spheroid concretions are also present in this horizon and in the parent material.

Tshombe soils are differentiated from those of the Aoda series in having a slightly brownish cast in the subsoil in having a higher proportion of very fine and fine sand and in having a more crumbly consistence in the B and C horizons. Soils of the Zeu series which occur in the northeastern part of the area tend to be more clayey and are slightly plastic.

The Tshombe loam mapped southeast of Luga and towards Mt. Akora appears to be somewhat more sandy, with appreciable fine and very fine sand. The texture would be a light loam in the topsoil and a loam or clay loam in the subsoil. It does appear to be somewhat less productive. Soils of this type mapped to the west and north of Tshombe forest tend to be easily erodible and have suffered considerable deterioration.

This type is fairly fertile and is rated just a little below the most fertile soils of the area. It can be used for all of the cultivated crops adapted to the area.

As an example of Tshombe clay loam the analytical data on and a description of Profile No. 636 are given below:

Tshombe clay loam, moderately eroded phase (Profile No. 636).

Location:	One kilometer south of Tshombe Mission.
Position:	Lower third of long (400 meters) 17 per cent slope.
Vegetation:	Savanna (burnt over) Hyparrhenia sp. Erythrina sp. Brush.

A_{11}	0-12 cm	Very dark gray clay loam. 5 YR 3/1 (dry). Moderately developed medium granular structure. Roots abundant.
A_{12}	12-25	Dusky red clay loam 2.5 YR 3/2 (moist) 5 YR 3/3 (dry). Well developed coarse granular to subangular blocky. Moderately friable. Many termite holes.
A_{13}	25-40	Dark reddish brown clay loam 2.5 YR 2/4-3/4 (moist) 5 YR 3/4-4/6 (dry). Moderately developed level subangular blocky structure. Friable. Roots abundant. Lower boundary clear.
B_{11}	40-75	Dark red clay loam 2.5 YR 3/6 (moist) 2.5 YR 5 YR 4/6 (dry). Weakly developed fine to medium subangular blocky structure. Firm in place when dry but friable when removed.
B_{12}	75-98	Lower transition B_1 horizon. Dark red clay loam 2.5 YR 10 R 3/6 (moist) 2.5 YR 4/6 (dry). Weakly to moderately developed fine subangular structure. Friable. Roots common.
B_2	98-200	"Dark horizon". Dark reddish brown clay 2.5 YR 10 R 3/4 (moist) 2.5 YR 4/4 (dry). Moderately developed fine subangular structure. Numerous moderately firm subangular aggregates or pseudo concretions. The dark reddish brown material of these firm aggregates appears to coat some of the aggregates of the soil matrix. Roots common. Boundaries gradual.
B_3	200-240	Red clay 2.5 YR 4/8 (dry). Some dark reddish brown moderately firm aggregates or pseudo concretions present. Upper boundary wavy with tongues of the dark reddish brown B_2 from above. Roots present.
C	240-335	Dark red friable clay 10 R 2.5 YR 3/6 (moist).
D_u	335	"Stone line". Cannot penetrate with auger.

Analyses of Profile No. 636 -- Tshombe Clay Loam
(Data by INEAC - Yangambi)

Horizon	Depth (cm)	Clay % 2 u	Silt % 2-50 u	Sand % 50-2000u	pH	Carbon %	Nitrogen %	Exchangeable bases ME/100 grs.	Exchangeable calcium ME/100 grs.
A_{11}	0-12	56.9	11.4	31.7	5.5	3.04	0.289	12.8	7.1
A_{12}	12-25	55.6	10.4	34.0	5.0	2.35	0.159	5.0	2.0
A_{13}	25-40	56.1	10.1	33.8	5.0	1.32	0.088	4.3	1.3
B_{11}	40-75	58.5	11.0	30.5	5.0	0.64	0.068	4.3	1.0
B_{12}	75-98	57.9	11.1	31.0	4.9	0.51	0.044	3.9	0.7
B_2	98-200	64.4	8.7	26.9	4.8	0.62	0.042	4.0	0.8
B_3	200-240	66.3	10.1	23.6	5.1	0.27	0.026	4.3	0.8
C	240-335	63.6	12.3	24.4	- -	0.24	0.023	4.0	0.8
D_u	335-	- -	- -	- -	- -	0.51	- - -	- -	- -

Tshombe clay loam, moderately eroded phase (Symbol $\frac{37}{B-2}$)

This soil is characterized by having a moderately thick and somewhat lighter colored topsoil. The A_{11} is generally between 7 and 14 cm. thick and tends to have a weak crumb or granular structure. Where mixing has been appreciable the topsoil is dark reddish brown. This is an extensive soil.

Tshombe clay loam, severely eroded phase (Symbol $\frac{37}{C-3}$)

The severely eroded phase of this type often has a dark reddish brown or reddish brown topsoil. In other cases the topsoil may be thin, generally less than 7 cm. and have a very dark gray color.

Tshombe clay loam, gently sloping phase (Symbol $\frac{37}{B-1}$)

This phase, which generally occurs on the nearly level to gently sloping summits has a somewhat thicker and darker B_2 horizon. This is dark red or dark reddish brown and extends from about 75 cm. to about the 200 cm. depth.

Tshombe clay loam, moderately eroded, gently sloping phase (Symbol $\frac{37}{B-2}$)

The topsoil of this phase has a very dark gray or dark reddish brown topsoil instead of black as in the normal type.

Tshombe clay loam, very severely eroded gently sloping phase (Symbol $\frac{37}{B-4}$)

A few small areas were found where very severe erosion had taken place as indicated by the reddish brown color of the surface soil. Usually these were around present villages or on old village sites.

Uswalo much (Symbol $\frac{25}{A-1}$)

This soil type includes the bog soils of the very poorly drained bottomlands of the streams and drainageways. In the virgin state the soils are wet for the major part of the time. Marsh grasses constitute the main vegetation in the undisturbed areas.

The profile of a black, very dark gray or very dark brown mucky surface, a dark brown somewhat peaty subsurface faintly mottled substratum of mineral soil. The surface soil which is about 25 cm. thick consists of a very dark brown or black loose muck with good crumb structure. In many cases some mineral soil may be mixed with the organic matter to give this horizon a loamy feel. The dark brown or dark grayish brown subsurface is likewise very high in organic matter and extends to a depth of about 50 centimeters. It is of a somewhat peaty nature in some cases having a fibrous nature. This merges rather abruptly into the dark gray clayey or loamy horizon which in turn extends to a depth of about 70 centimeters. The latter horizon consists of a mixture of mineral soil and organic matter and often has a massive structure.

Brownish staining along root channels are common. It passes into a gray, plastic if clayey, horizon with a massive structure. This usually merges into gray coarse sandy and gravelly material within a meter or so of the surface. Free water is usually encountered within about 60 cm. of the surface.

A description of a profile sample of Uswalo much (Profile No. 634) together with some analytical data are included in the discussion of bog soils given earlier in the report.

This inextensive but common soil type is important agriculturally. It has a comparatively high level of fertility which together with a high water table makes this a productive soil during the dry season. Irish potatoes and corn (maize) are common crops. Some bananas are grown along the edge.

Zeu clay loam (Symbol $\frac{77}{C-1}$)

Included in this type are the Latosol soils developed on deep moderately clayey friable materials which appear to be derived largely from schisty rocks. They occur on moderately rolling topography most commonly but they also occur on gently sloping or nearly level psotions as well. Hyparrhenia savanna normally occurs on these soils where they have not been disturbed greatly. Where erosion has been serious the vegetation is more mixed and may carry appreciable areas of Loudetia sp.

The profile of Zeu soils consists of a fairly thick very dark gray or dark reddish brown moderately granular topsoil, a red or dark red upper subsoil with yellowish tinge, a dark reddish brown lower subsoil and a red parent material. Generally the clay content of the solum is moderately high to high and the consistence moderately sticky and plastic. It is friable throughout though the solum-parent material transition is inclined to be somewhat firm in place and may be somewhat less friable than the other horizons. Some medium or coarse quartz sand may be present in the solum.

Soils of this series are differentiated from those of the Tshombe series in being somewhat more clayey and more sticky and plastic. Those of the Aoda series have less clay and carry more medium and coarse quartz sand.

This is a common soil type in the northcentral and northeastern part of the area. It has a very dark gray clay loam moderately acid topsoil which averages somewhere between 12 and 15 cm. in thickness and has a fair to moderately developed fine granular or crumb structure. Roots are abundant in this horizon. The topsoil grades through dark reddish brown somewhat heavier subsurface with coarser granular structure into the red B_1 horizon at about 40 cm. The latter horizon carries a lightly more clay, has a weak friable subangular structure and generally is moderately plastic. The color is red though it may have a slight yellowish tinge when dry and ranges from 2.5 YR 4/6-3/6 to 5 YR 2.5 YR 4/6 in the dry state. It merges into the dark reddish brown lower subsoil, the B_2 horizon, ("Dark horizon") at about one meter which in turn passes into the B_3 at about the two meter depth. This "dark horizon" is generally crumbly or has a weakly developed friable subangular structure that breaks down easily into weak fine crumb when moist. Some dark reddish brown firm aggregates are present. The red B_3 horizon which extends to about the two and one half meter depth, has a friable, weakly to moderately developed subangular structure and carries fine subrounded red firm pellets. It merges gradually into the red friable clayey parent material. Some medium or coarse quartz sand may be present in small quantities throughout the profile.

Zeu clay loam appears to have a fairly high level of fertility and should be adapted to all crops grown in the area. It is easily erodible so would require more conservation measures than soils of the Aoda or Tshombe series.

Profile No. 665 is included as an example of Zeu clay loam.

Location: About 4 km. northeast of Munzi Mt., near north boundary.
Position: Middle of long (500 meter) 10 per cent slope. Elevation 1620 meters.
Vegetation: Native pasture, brush, forbs, Erythrina.

A_{11} 0-12 cm. Black clay loam (moist) 5 YR 2/1 (dry). Moderately developed fine crumb structure. Roots abundant.

A_{12}	12-32	Dark reddish brown clay loam 5 YR 3/2 (dry). Moderately developed coarse granular structure. Friable. Roots abundant.
A_{13}	32-45	Dark reddish brown clay loam 5 YR 3/4 (dry). Moderately developed coarse granular structure. Roots common. Lower boundary clear.
B_{11}	45-72	Dark reddish brown clay 5 YR 3/6-4/6 (dry). Moderately developed fine subangular structure. Friable. Some penetrations of darker material from A_{13} along cracks and root channels.
B_{12}	72-97	Dark reddish brown clay. 2.5 YR 3/4 (moist). 5 YR 3/4-4/6 (dry). Moderately developed fine subangular structure. Friable. Some moderately firm aggregates or pseudo concretions.
B_{21}	97-172	"Dark horizon". Dark reddish brown clay 2.5 YR 3/4-3/2 (moist). 5 YR 2.5 YR 3/4 (dry). Weakly developed fine to medium subangular blocky. Very friable, porous. Some moderately firm aggregates or pseudo concretions present. Moderately sticky and plastic. Upper and lower boundaries diffuse.
B_{22}	172-215	Dark red clay 2.5 YR 3/6-3/4 (moist) 2.5 YR 4/6 (dry). Moderately developed fine subangular structure. Friable. Occasional dark red moderately firm pseudo concretions. Roots common. Lower "dark horizon" transition.
C	215-300	Red clay 2.5 YR 4/6 (moist) 2.5 YR 4/6 (dry). Very weakly developed fine to medium subangular structure. Friable. Fine red moderately firm pseudo concretions.
D_{1u}	300-310	"Stone line". Quartz fragments. Some well rounded quartz gravel. Fine white mica present.
D_2	330-375	Red micaceous clay.
D_3	375-400	Red micaceous clay mixed with gray and yellow material.

Analyses of Profile No. 665, Zeu Clay Loam, Moderately Eroded Phase
(Data by INEAC - Tangambi)

Horizon	Depth (cm)	Clay % 2 u	Silt % 2-50 u	Sand % 50-2000 u	pH	Carbon %	Nitrogen %	Exchangeable bases ME/100 grs	Exchangeable calcium ME/100 grs
A_{11}	0-12	52.9	14.9	32.2	5.5	2.86	0.302	13.4	7.7
A_{12}	12-32	55.0	13.3	31.7	5.0	2.49	0.158	3.1	1.1
A_{13}	32-45	52.6	13.8	33.6	5.0	1.49	0.101	2.6	- -
B_{11}	45-72	58.1	12.5	29.4	5.0	0.93	0.076	2.9	- -
B_{12}	72-97	59.0	12.3	28.7	4.7	0.82	0.042	2.9	- -
B_{21}	97-172	57.7	12.2	30.1	5.0	0.78	0.043	2.9	- -
B_{22}	172-215	57.9	13.0	29.1	5.0	0.51	0.031	3.0	- -
C	215-260	55.6	15.2	29.2	5.1	0.21	0.016	3.4	0.8

Zeu clay, moderately eroded phase (Symbol $\frac{77}{C-2}$)

This is a common and extensive phase and differs from the normal type primarily in the thickness and color of the topsoil. It is generally a very dark or dark reddish brown to a depth of about 10 cm.

Zeu clay loam, severely eroded phase (Symbol $\frac{77}{C-2}$)

The dark topsoil of this phase is generally thin being less than 7 cm. thick and often has a dark reddish brown color. It sometimes is moderately hummocky with the hummocks up to about 10 cm. high.

Zeu clay loam, gently sloping phase (Symbol $\frac{77}{B-1}$)

This phase occurs on nearly level or gently sloping positions, commonly broad hilltops.

Zeu clay loam, severely eroded, gently sloping phase (Symbol $\frac{77}{B-3}$)

This soil occurs on the gently sloping or nearly level positions, generally ridge summits. It differs from the normal type in slope and in having a lighter colored topsoil which is a dark reddish brown or reddish brown.

FERTILITY STATUS OF NIOKA SOILS

As a general group the Humic Red Latosol soils are moderately fertile. There is considerable difference however among the various soil types depending on the kind and degree of weathering of parent material. The dark surface soil which is up to 20 cm. thick has a relatively high organic matter content (5 to 10 per cent) and apparently can supply appreciable quantities of some of the plant nutrients. Its exchange capacity ranges from 10 to 25 milliequivalents of which from about 25 to over 50 per cent is saturated with calcium. Most of these soils are only moderately or slightly acid in this horizon with pH somewhere 5.5 to 6.5. A few of these soils are more acid however with the pH values as low as 5.1. Analyses of the subsoils, both B_1 and B_2 horizons present a different picture. This part of the solum is acid with most of pH values being around 4.9 or 5.0. Furthermore, the exchange capacity is low, usually between 5 and 8 milliequivalents of which only around one milliequivalent or less of exchangeable calcium present.

Tests to determine the level of "available" phosphorus and potassium* in some of the soils made in the Ohio State University Agronomy Department Laboratory are given below:

*Note: ("Available phosphorus and potassium is in terms of this quantity of these elements in a seven-inch (17.5 cm) layer of soil.)

SOIL		"Available" phosphorus (NH_4F-HCl extraction)		"Available" potassium (Neutral solution $NaNO_3$ extraction)	
		Pounds per A.	Kilograms per hectare	Pounds per A.	Kilograms per hectare
Aoda clay loam - Profile No. 705					
A_{11}	0-17 cm.	23	26	960	1090
B_1	42-72	14	16	216	245
B_2	100-205	12	14	92	104
Tshombe clay loam - Profile No. 703					
A_{11}	0-16 cm.	23	26	564	640
B_1	46-100	22	25	107	121
B_2	150-200	18	20	99	112
Shari clay loam - Profile No. 596					
A_{11}	0-15 cm.	69	78	752	853
B_1	40-85	20	23	89	101
B_2	105-175	22	25	33	37
Mboro clay loam - Profile No. 678					
A_{11}	0-13 cm.	34	39	260	295
B_1	39-74	14	16	150	170
B_2	134-185	19	22	103	117
Djumali clay loam - Profile No. 701					
A_{11}	0-14 cm.	91	103	1000	1134
B_1	45-100	22	25	548	622
B_2	135-180	23	26	232	263
Uswalo muck - Profile No. 702					
H_1	0-25 cm.	138	156	356	409
H_3	48-68	11	12	68	77
Uswalo muck					
H_1	0-20 cm.	24	27	137	155
H_3	30-56	67	65	21	24

The results show a level of "available" phosphorus by the ammonium fluoride extraction method. Only the soils developed on the dark basic rocks show appreciable "available" phosphorus. It is particularly low in the subsoils of the Humic Red Latosols.

Higher levels of potassium especially in the surface horizon are indicated. Thus as far as the analyses and tests indicate these soils have appreciable calcium and potassium available and that a large portion of these elements occurs in the dark topsoil. Phosphate supply on the other hand is low.

Another general conclusion that can be drawn from these tests and the analyses made at Yangambi is that the subsoil of these Latosols carry meager quantities of the "available" nutrients considered. The importance of the dark topsoil as a factor in the fertility of these soils and the extreme need for its adequate conservation are well demonstrated by these results.

The widespread use of muck soils of the drainageways for crop production is borne out by these tests and analyses. Exchangeable calcium and also available phosphorus and potassium are appreciably higher in the Uswalo muck than in the other soils. Apparently their higher mineral nutrient level and a high water table makes this soil particularly valuable crop production especially during the dry season.

The remaining group of soils, the Lithosols, the Gray Hydromorphic and the Podzolic should have relatively high fertility levels. The proportion of weatherable minerals in these soils is considerably greater than in the Latosols.

It is realized that these analyses and tests should be interpreted with considerable caution. These results may not be correctly indicative of the actual availability of the three elements considered. In addition little data is available on the other mineral nutrients including the trace elements. Considerably more field and laboratory investigations are needed. Some work is being carried on at the INEAC Station at Nioka. It should be expanded to take in the more important soils of the area.

SOIL DETERIORATION

Deterioration of soils through erosion and through destruction of organic matter and structure is a serious problem. While most of the soils in the virgin state have at least a weakly granular topsoil with considerable organic matter, this condition tends to deteriorate under cultivation or under certain types of vegetation. No doubt physical disturbance and higher temperatures of the exposed soils contribute to this deterioration. The problem of higher temperatures is especially important. Bernard (17) reports an increase in temperature of 17.5°C in bare soil over that under forest at 5 cm. depth at Yangambi. Comparable differences in soil temperatures can be expected at Nioka. Some of the native vegetation such as Loudetia savanna provides less cover for the soil than some of the other grasses. The generally lower organic matter content of soils under Loudetia may be attributed in part at least to this effect.

Accelerated erosion by water is also an important soil degradation process in the area. A casual observation made during periods when vegetation is rank may not disclose the extent or severity of this process. Upon critical examination, however, it is seen that appreciable soil disturbance by water erosion has taken place locally and that the extent of damage on some soils and in some areas is considerable. True, there are no long deep gullies that generally symbolize erosion in its more spectacular form but this does not mean that other evidence is lacking. There are many areas, some of them large, where the topsoil has a reddish brown color. Normally most of the soils of the area have a dark surface to a depth of about 15 cm. or more. A reddish brown color is indicative of considerable removal or disturbance of this dark topsoil, or at least sufficient removal to bring some of the reddish colored subsoil to the surface by cultivation or exposure. Too, a close examination has shown that though the surface is still dark, the thickness of topsoil has been reduced appreciably. Thus many of the areas have a dark topsoil of thickness ranging from 8 to 12 cm., whereas in the more secluded spots it may be well over 15 cm.

There are extensive areas where the surface has a hummocky micro-relief. This is particularly common and extensive in the Shari basin but it also is encountered in more localized areas in the northeastern portion of the survey block. A bunch grass vegetation with Loudetia spp. prevailing is generally the dominant cover. The soil hummocks, some of which are up to 30 cm. high have been either built up or preserved around the clumps of the bunch grasses. The spaces in between clumps are bare and often show a more pronounced reddish soil. It was estimated in

the field that up to 80 per cent of soil may be bare or exposed under this type of vegetation. Considerable erosion either by running water or raindrop splash has had to occur to cause such hummocks. A close examination shows that these grass clumps or other vegetation debris act as obstructions to run-off waters and that most of these obstructions have some eroded soil material built up behind them. Some of these minute steps or terraces are up to 20 cm. high.

The heads of many draws are eroding actively and in some cases there are raw exposures of the underlying material. This form of erosion, while encountered to some extent practically anywhere in the area, seems to be particularly prevalent along the lower reaches of the Niagaki basin.

Many of the hillside cultivated fields though formed on the contour are developing a bench like form. It appears that the soil has moved from the upper side of the field and it is piled up back of the lower field boundary. Some cases were noted where the field border below is 60 cm. lower than the adjoining one upslope.

It has been noted too that the topsoils of the lower slopes are often thicker than those of the upper slopes or summits. It appears that the lower slopes are generally better protected against erosion because of the heavier vegetative cover. In addition to protection this situation encourages desilting and so the soil is built up.

Several factors contribute materially to erosion. Climate, land use and management, vegetative cover, topography and soil exert their influence on erosion in one way or another.

The climatic factor has a pronounced effect primarily because of the rainfall characteristics. First of all, most of the rainfall occurs in the two rainy seasons, April to June, and August to November. Observations at Nioka indicate that 68 per cent of the average annual precipitation comes in these two periods. The first of these rainy periods is significant since it follows a long dry period when most of the grass is burned and the soil is bare. This combination of heavy rains and scant cover is bound to produce erosion. In addition to being seasonal in nature the rains are also intense, many of them coming as heavy showers with resultant high run-off and terrific raindrop impact. This is a destructive combination, particularly on bare exposed soil.

Some wind erosion by dust devils has been noticed after the grass cover has been burnt. This, however, appears to be slight.

Land use or mangement is another important erosion factor. Cultivation generally tends to promote erosion through exposing the soil to running water and raindrop impact. Where the fields are large and the topography rolling, the effect of running water is increased. Fortunately, in this area the fields are small and narrow and most of them are situated on the contour. Even so, some erosion takes place in these narrow fields. They are exposed for a time so the soil tends to work its way down slope and accumulate in the lower part of the fields or the lower slopes. It has been observed that because of this the fields tend to develop a bench-like form. Some downslope soil movement can be attributed to the downslope method of hoeing which is the only tillage operation practiced by the natives. They generally hoe down slope so each operation tends to move the soil in that direction.

Most of the crops grown by the natives are of a clean-tilled variety, such as sweet potatoes, manioc, beans, sunflower, corn, and Irish potatoes. As a rule an attempt is made to plant these on the contour or broadcast but some soil movement occurs.

Much erosion has occurred on the grasslands because of management practices, such as overgrazing and burning. There is a tendency for native cattle to be concentrated around village with resultant decrease, both in density and in duration, of grass cover. There is also a tendency on part of the white ranchers to overstock their pasture lands because of the generally small holdings they are permitted to acquire. Such practices increase erosion. A common observation in grazed areas is that considerable erosion has taken place around head of drainageways. Most of these drainageways are of a marshy nature so the cattle when moving from one hill to the next go around the heads of these draws. This causes considerable tramping and overgrazing and a noticeable increase in erosion of these locations.

Burning of grasslands is by far the most significant management practice as far as erosion is concerned. Every year the natives burn practically all of the grassland during the dry season. Thus for several months the soil is bare or inadequately protected against the elements. Large areas are affected, so with the long slopes that are common to the area considerable and rapid run-off takes place. In addition to exposing the soil, these frequent burnings make it possible for certain vegetation forms to come in that are less effective in controlling erosion. It is these repeated burnings that apparently maintain a more erodible savanna cover.

There is a wide range in the effectiveness of the different forms of vegetative cover common to the area in controlling erosion. Most of the area has a cover of savanna. Some of its compoent grasses provide good cover and protection to the soil and are quite effective in controlling erosion. Species of Hyparrhenia, Disitaria, Pennisetum are particularly important representatives of this group. They seem to provide a good cover for interception of rainfall, and, in addition, have extensive and spreading root systems that make the soil more resistant to erosion. Another group of grasses are much less desirable in this respect. Most of these are bunch grasses and include species of Loudetia, Cymbopogon, Exotheca, Elionurus, Eragrostis, etc. It appears that erosion is more active when bunch grasses are dominant. As mentioned previously a good proportion of this soil surface, up to 80 per cent, is bare thus exposing it to the elements. The root systems of these grasses appear to be localized around the clumps so that the soil between clumps of grass does not have the benefit of protection or granulating effects of more spreading root systems. These grasses also tend to be erect and open so there is less interception of rain. All these characteristics make the latter group of grasses less effective in controlling erosion.

The various brush and forb species appear to occupy an intermediate position as far as effectiveness of controlling erosion is concerned. They generally come in on temporarily idle land so occupy the area for a limited time only. The forest cover is largely confined to lower valley sites. It provides very effective protection.

A large part of the area has a topography with considerable slope. Cultivation occurs on all but the steepest slopes but is most extensive on land classed as gently sloping, moderately sloping or strongly sloping, i.e., on slopes up to 25 per cent. In addition to slope gradient, slope length is also an important run-off and erosion factor. Slopes in the area are generally long, most common being from about 100 meters to about 400 meters in length. The longer slopes appear to be most prevalent in the Shari area. Such slope lengths and gradients are important factors contributing to erosion.

Slope appears to be a factor in determining the base status of some of the surface soils. There is a tendency for the surface soils of the nearly level or gently sloping areas to have a somewhat higher base status and pH than do the soils on the slopes. On comparison, the pH and exchangeable values of the A_{11} or A_p horizon of soil developed on materials derived largely from granitoid rocks show considerable variation but as a whole the values of slope soils is somewhat lower. These values are shown below.

Aoda clay loam, gently sloping phase, Slopes 0 - 8%		Aoda clay loam, Slopes 8 - 15%	
pH	Exch. calcium	pH	Exch. calcium
6.5	10.7 ME	5.7	9.5 ME
5.8	7.3	6.0	9.3
6.7	13.1	5.3	3.6
6.6	11.3	5.3	7.4
5.7	5.8	5.1	- -
5.5	6.9	5.7	5.3

This apparent difference may be due to the greater degree of erosion on the slopes or due to greater loss of soluble ash material following savanna fires. The latter seems to be substantiated by the high base status of the surface mantle of soils. The pH and exchangeable calcium of this thin mantle are much higher than the values for the A_{11} horizon proper. The results of analyses made in three cases of material scraped from the soil surface and of the entire A_{11} horizon at the same location are given. The soil was Shari clay loam.

	Material scraped from surface (upper 2 cm) pH	Exch. calcium	$N/20$ H_2SO_4 Sol. P_2O_5	A_{11} horizon including surface material pH	Exch. calcium	$N/20$ H_2SO_4 Sol. P_2O_5
Profile 544	6.2	12.8	7.2	5.2	5.5	3.6
Profile 596	6.2	10.1	6.0	5.3	3.1	2.6
Profile 598	6.6	12.2	6.8	5.8	6.8	3.4

The concentration of mineral nutrients at the surface would encourage loss by run-off either as solid or as dissolved material.

The characteristics of the area exert a strong influence on the extent, severity and nature of erosion. Some of the soils appear to be considerably more erodible than others. In general the soils developed on materials derived from granitic rocks are relatively resistant. The vegetative cover they commonly support belongs to the group of species less conducive to erosion. Further the topsoil exhibits a better developed and more stable form of aggregation than that of some of the other soils. Thus despite the steepness of slope and considerable cultivation this combination of good cover and good aggregation has apparently been fairly effective in keeping erosion down. The other soils of the area are more erodible. Those developed on basic rock materials appear to have fairly good aggregation but are intensively cultivated in practically all cases. This intensive use coupled with the generally steep terrain on which they occur may be responsible for the severity of erosion that is often encountered on these soils. Another group of soils that appear to be fairly erodible are those developed on materials derived largely from a complex of metamorphic rocks. They have been put to considerable use by the natives - both for cultivated crops and for grazing. The latter use is particularly widespread since the area is heavily populated and livestock raising is a popular enterprise with the natives in the eastern part. Overgrazing is a common occurrence. These soils appear to have only a moderately stable aggregation and serious erosion is common. The last groups of soils - those that are developed largely on materials derived from laterite are important because of their extent and their erodible nature. They occupy practically all of the Shari basin and a sizeable area in the Omi River watershed. Serious erosion is widespread - a good deal of it is of a severe class yet they have been subjected the least of all soils to cultivation or grazing. They appear to possess a low degree of stability of aggregation and a low level of fertility. Bunch grasses constitute the dominant cover which in itself is conducive to erosion.

Erosion was one of the soil characteristics in addition to morphology and slope that was evaluated, classified and delineated on the map in soil mapping operations. During the coarse of preliminary field studies of the soils of the area it was noted that in general they had a relatively thick (about 15 cm) dark surface soil where apparently erosion had not been too active. It was decided by the pedologists that a soil having a dark topsoil of this thickness would be classified as suffering little or no deterioration. A soil having a dark topsoil of only about half this thickness or less would be classified as being severely eroded. A topsoil of intermediate depth would indicate moderate erosion. In many cases where apparently severe erosion had occurred but where cultivation was still carried on the shallow topsoil and reddish topsoil has been mixed to produce a surface of reddish brown color. Such soils were also classified as being severely eroded. A fourth category of erosion, designated as very severe was used to identify areas where all of the dark topsoil has been removed by erosion. The degree of erosion of an area was evaluated by checking several samplings of topsoil taken in the vicinity of a pit or a boring used for routine soil examinations. No significant gullying was encountered.

PRODUCTIVITY OF SOILS

In estimating the productivity of the soils, fertility is only one of several factors that have to be considered. Soil moisture availability for one is another factor important. Furthermore the climate and topography may influence the soil productivity by influencing the kind of crops that can be grown.

The climate of the Nioka area with its moderate temperatures and alternating wet and dry seasons favor some crops and excludes others. It is relatively cool so that some of the

common tropical crops such as rubber, cotton, and oil palm are not grown. On the other hand many of the vegetable and fruit crops common to the temperate regions are produced. These include such crops as Irish potatoes, cabbage, turnips, lettuce, carrots, strawberries, and possibly others. Thus a wide variety of crops are produced in the area. Sweet potatoes, manioc, corn, eleusine, sorghum, sunflowers, beans and Irish potatoes are some of the more common crops grown for native food. The plantation crops are mainly coffee, though some quinine, geranium and eucalyptus are also produced in the area. In addition to cultivated crops the adapted grasses do well on these soils so that cattle raising is a major agricultural industry. This enterprise is carried on by both the European settlers (colons) and the natives.

One characteristic of the climate that very definitely effects the agriculture of the area is the prevalence of the "big" dry season. From about the end of November through March is a period of inadequate rainfall. Warm, drying, northerly or northeasterly "Sudanese" winds prevail. The vegetation either dries up or is set back appreciably in most locations, the only exceptions being certain locations where the soil is able to supply adequate moisture or where the sites are less exposed.

The crests and shoulders of hills which constitute some of the drier sites normally, seem to be especially susceptible to these adverse effects. Soils of the uplands examined during the latter part of the "big" dry season appeared to be dry and firm down to about 75 to 90 cm.

Thus fertility as well as moisture characteristics and the topographic situation of the various soil types and phases have to be considered in evaluating their productivity.

In order to obtain some idea of the moisture properties of these Latosol soils, moisture equivalent and moisture at 15 atmospheres on pressure membrane were determined on the B_1 and B_2 horizons of two common soil types. The data are given below together with the calculated "available" moisture, the difference between above values expressed in centimeters and in inches to a depth of two meters. A volume-weight of soil of 1.1 was used in these calculations. The moisture equivalent values are taken as field capacity while those at 15 atmospheres represent permanent wilting moisture. The data are given below:

Soil Type	Horizon	Moisture equivalent	Moisture 15 atmos.	"Available" moisture storage capacity in two meter depths: Pct.	Cm.	Inch
Shari clay	B_1(40-85 cm)	25.8	18.6	7.2	15.8	6.3
loam	B_2(105-175 cm)	25.2	17.3	7.9	17.4	7.0
Aoda clay	B_1(40-72 cm)	23.5	15.4	8.1	17.9	7.2
loam	B_2(100-205 cm)	25.8	18.8	7.0	15.4	6.2

The soils are rated according to the several major types of agricultural use, namely, plantation crops, native food crops and grazing. Rating for forestry is not attempted, though it is realized that this is an important industry in the area. In making a classification of land in the area, it was felt that some soils are best suited for forestry and have been so classified.

The order of productivity ratings of the various soils is based largely on the judgment and observations of the soil surveyor and should be revised as more information is available. Since actual production data are meager the ratings are broad and largely relative. Only in a few cases are yield predictions made.

No yield predictions are made for the plantation crops. The soils considered suitable for this use include those of at least moderate fertility and depth and have not been seriously affected by erosion. Starting with the most productive soil type the various soils considered suitable for plantation crops are listed in order of decreasing productivity:

Djumali clay loam
Djumali clay loam, moderately sloping phase
Gote clay loam
Gote clay loam, gently sloping phase
Djuda clay loam
Aoda clay loam, gently sloping phase
Aoda clay loam
Tshombe clay loam
Zeu clay loam

Rona loam, gently sloping phase
Luga loam, gently sloping phase
Gote clay loam moderately eroded phase
Rona loam
Luga loam

For native food crops the relative ratings of the various soils are likewise listed in order of decreasing productivity. Cropping systems and management as practiced by the natives is assumed.

Some idea of the actual production that can be expected on the various soils put to this use can be derived from the general results obtained at the INEAC station. On a soil that is largely Aoda clay loam, moderately eroded phase, which is rated as being of medium productivity for the area, the following are the general production data:

Crop	General yield with better varieties	
	Kilograms per hectare	Bushels or pounds per acre
Corn (Maize)	2500 (shelled)	37 bu.
Sweet potatoes	30000	440 bu.
Manioc	20000	9000 lbs.
Irish potatoes	5000	75 bu.
Beans	1000	15 bu.

For soils rated as being of "moderately high" productivity the predicted yield levels can be raised about twenty-five per cent. For soils rated as "low" the predicted yields are set at about 50 per cent of the production figures given above. The various soils are listed in order of decreasing productivity with respect to native food crops:

Moderately high productivity
Uswalo muck
Djuda clay loam
Djuda clay loam, sloping phase
Djumali clay loam
Djumali clay loam, moderately sloping phase
Gote clay loam
Gote clay loam, gently sloping phase
Setchama clay loam
Rona loam
Aoda clay loam
Tshombe clay loam
Zeu clay loam, gently sloping phase
Zeu clay loam
Rona loam, gently sloping phase
Luga loam, gently sloping phase
Rona loam, moderately rocky phase
Luga loam
Djoda clay loam

Medium productivity
Aoda clay loam, moderately eroded phase
Aoda clay loam, moderately eroded, gently sloping phase
Rona loam, moderately eroded phase
Rona loam, moderately rocky, moderately eroded phase
Tshombe clay loam, moderately eroded phase, gently sloping phase
Tshombe clay loam, moderately eroded phase
Zeu clay loam, gently sloping, moderately eroded phase
Zeu clay loam
Luga loam, moderately eroded phase
Grobler clay loam, gently sloping phase
Grobler clay loam

Low productivity
- Pegno gravelly loam
- Pegno gravelly loam, sloping phase
- Pegno gravelly loam, moderately eroded sloping phase
- Libi loam
- Pegno gravelly loam rocky sloping phase
- Grobler clay loam, moderately eroded, gently sloping phase
- Grobler clay loam, moderately eroded phase
- Aoda clay loam, severely eroded phase
- Rona clay loam, severely eroded phase
- Tshombe clay loam, severely eroded phase
- Mboro clay loam
- Kampala clay loam
- Djumali clay loam, severely eroded, moderately sloping phase
- Gote clay loam, severely eroded, gently sloping phase
- Gote clay loam, severely eroded phase
- Shari clay loam, moderately eroded phase
- Kam pala clay loam, moderately eroded phase

This broad productivity rating of soils should not be used indiscriminately, for all of the native crops. As an example, Irish potatoes and corn do better comparatively on Uswalo muck than do the other crops listed. Again sweet potatoes and manioc appear to do quite well on the shallower coarser textured soils so the general rating given above is not indicative of the productivity of some of the soils with respect to these two crops.

The productivity ratings of the soils of the area with respect to grazing are also broad. In general the soils that are more productive in plantation or native food crops rate higher with respect to grazing. Expressed in terms of animal units, the average carrying capacity is around 3 hectares per animal unit per year. The carrying capacity for average native pasture is estimated to range from about 2-1/2 to about 3-1/2 hectares per animal unit. It was noticed that soils that are more productive with respect to plantation crops or native food crops, also support better stands of the more desirable or palatable grasses. Thus the soils rated as moderately high for native food crops would fall in the upper range of estimated carrying capacities, i.e., between 2-1/2 and 3 hectares. Those rated as low would fall into the lower range. This lower range also includes all of the soils whose productivity is considered to be too low to be suitable for native food crops.

No attempt is made to rate the soils for forestry use. There is a need for forestry plantings to supply the needs of the natives. It is recommended in this report that in the survey area the soils carrying a forest cover at present or those whose productivity is considered to be too low for native food crops be reserved for forestry.

AGRICULTURAL POTENTIALITIES AND PROBLEMS OF THE NIOKA AREA

The area surveyed has good possibilities for certain types of agriculture. Moderately productive soils and a uniformly mild climate combine to make this area suitable for comfortable habitation and for certain types of agricultural pursuits.

Cattle raising is an important industry now and should continue to expand. The area will be a real asset in this respect to the overall economy of Belgian Congo. It will become even more important as the development of the country progresses. This and similar areas of Humic Red Latosols appear to be the major potential suppliers of animal products to the rest of the country. The area because of its altitudeand the resultant cooler tropical climate appears to be more favorable to cattle production than the other parts of the country. Insects, pests and disease while a big problem appear to be less virulent than in lower warmer areas. Even now a considerable number of cattle is raised and products such as meat and butter are shipped to Stanleyville.

The cattle industry while offering good possibilities is also beset with some problems which have to be met. There is a need for more productive and resistant strains of cattle. Further there are many insect pests and diseases even in this relatively cool tropical climate that reduce the cattle numbers and weight gains appreciably. Quality of pastures needs to be improved. There is also a need for adequate pastures during the big dry season when drouth and burning reduce the carrying capacity to a critical point. This means not only improvement of varieties of grasses but also improved methods of range or pasture management. The INEAC station at Nioka is working on some of these problems. Better pasture management, stocking and distribution of cattle is also necessary in order to minimize overgrazing and soil deterioration. This appears to be especially desirable on the overcrowded pastures around

many of the native villages in the eastern part of the area. There is also a tendency for some overstocking by the white settlers. Their holdings are generally too small to support the herds they operate. The most apparent immediate need is for greater educational and extension work with the natives. There is also a need for closer contact between the technical workers in this field and the white settlers and native chiefs interested in cattle raising.

Cattle raising offers an effective way of utilization and conservation of the Humic Red Latosol soils. It would make it possible to utilize these soils without exposing the dark topsoil to extensive deterioration.

Production of native food crops is another essential agricultural activity. This agricultural pursuit must be carried on with both cattle raising and plantation operations. Native food crop production can be made more effective by using the more productive soils in the area while those of lower productivity can be pastured. More systematic rotations of fields would permit grazing on the land in grass fallow. The problem of declining soil fertility after two or three crops is another problem that should be investigated. Application of ordinary fertilizers does not seem to overcome this problem so there is an urgent need for research into this behavior of these soils.

Conservation of soils used for native food production is still another problem needing attention. Exposure of soil to rain impact and to excessive temperatures are two of the factors that have to be met. No suitable solution can be recommended at present.

The use of the very poorly drained soils for production of native food crops during the dry season should be given more attention. These soils are productive and are used to some extent at present. Development of suitable drainage and fertility investigations are both needed on these soils.

Limited production of some plantation crops has a place in the agriculture of the area. These crops constitute some of the more easily exportable produce. Only the more productive soils in the area however should be devoted to this purpose. Problems of soil fertility, soil conservation and site evaluation pertaining to plantation operation all need investigation. Site characteristics appear to be an important factor in coffee production in this area. More should be known about what constitutes a good site for this purpose.

Only the more productive soils should be considered for plantation crops. It is estimated that about 20 per cent of the area is occupied by soils suitable for this purpose. This does not mean that all of the soils so designated should be used for this purpose.

A broad classification of land according to intensity of use has been prepared for the area and is presented in the following table.

Use	Per Cent of Area
Plantation or native food crops or grazing	20
Native food crops or grazing	47
Grazing	13
Forest and pasture	15
Marsh	5

Lack of good transportation facilities is the most important factor preventing more rapid expansion of agricultural development. Stanleyville, the major upper terminal of Congo River traffic, and the main western outlet for agricultural exports, is about 500 miles away. It is connected by a dirt road that is often muddy or rough. It takes two days to cover this distance by truck. The travel is slow, costly and tiring. The outlet to the east is by way of East African Railroad. Again truck and ferry transportation has to be used to reach rail head. Either way the transportation facilities are slow and expensive. Freight has to be handled several times before it reaches either of these main outlets. Any appreciable expansion of agricultural production is going to depend on improvement of these transportation facilities.

RECOMMENDATIONS

There are a number of agronomic problems facing the agriculture of the area. Solution of some of these can be attained only through increased research and experimental work while others need a stepped-up program of education and extension. These general agronomic problems are:

1. Deterioration of soil through loss of organic matter, breakdown of soil structure and erosion.
2. Sharp decline of yields after two or three crops are grown.
3. Overstocking and overgrazing of some areas.
4. Prevalence of less palatable grasses over large areas.
5. Failure of coffee to bear fruit in some locations though good bushes are produced.
6. Differences in kind and age of parent materials and their effect on soil fertility.

The recommendations made below should contribute to a solution or alleviation of these problems:

1. Expand fertility research program in order to investigate:

   a. Fertility changes in soils under different cropping systems practiced in the area.
   b. Fertility levels of the different soil types.
   c. Status of trace elements.

2. Initiate investigations of organic matter and soil structure changes associated with different types of use and soil management.
3. Make reconnaissance of eastern Belgian Congo to determine extent and distribution of Humic Red Latosol soils.
4. Initiate a program for greater utilization of the very poorly drained soils, i.e., Uswalo muck, for use during dry season.
5. Undertake investigation of Micro-climate as a factor influencing site suitability for different crops and grasses.
6. Place greater emphasis on education and extension work. There is a need for closer contact between the technical workers and the white settlers and village chiefs to permit better use of agronomic information already available. Specifically, there is a need for a range management specialist to do extension and educational work along this line.
7. Expand parent material investigations.

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